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May 19, 2006

BY ELECTRONIC FILING

Magalie Roman Salas, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: *Broadwater Energy LLC*, Docket No. CP06-54-000
Broadwater Pipeline LLC, Docket Nos. CP06-55-000 & CP06-56-000

Dear Ms. Salas:

Enclosed for filing in the referenced proceedings are the responses of Broadwater Energy LLC and Broadwater Pipeline LLC to the Commission's second set of Environmental Information Requests, Nos. 1–12, issued May 1, 2006.

Please do not hesitate to contact me with any questions regarding this submission.

Respectfully submitted,

/s/

Brett A. Snyder

Enclosures

cc: James Martin, FERC (paper & electronic copy)
Cooperating Agencies (paper & electronic copy)
ENTRIX, Inc. (paper & electronic copy)
Roger Stebbing and Associates (paper & electronic copy)

EIR2-1

Request:

Provide the status of all applicable permits associated with potential onshore facilities and activities.

Response:

As indicated in our prior filings, Broadwater intends to utilize existing facilities for all onshore activities required during construction and operation of the project. Further, based on the proposed use and operation at the Broadwater onshore facilities, no Federal permits will be required. Other permits that may be required include building permits and a certificate of occupancy for the modification of any existing structures to accommodate needed office or storage space. These permits will be needed for facilities in either Port Jefferson or Greenport New York, depending on the final location of the onshore facilities. Requests for permits and authorizations have not been submitted at this time because it is too early in the project planning process to determine the final location of the onshore facilities and what modifications to existing structures may be needed to support long-term project operations.

EIR2-2

Request:

Provide a detailed description of the heliport, potential FAA requirements and restrictions, and a discussion of any impacts that could result from use of the heliport. Describe any NYSDOT and Suffolk County permitting requirements for, or restrictions on, use of the proposed heliport.

Response:

The helideck on the Broadwater FSRU is for emergency transport only. Should emergency transport be required, a helicopter will be requested from an onshore location. The 18 metre diameter helideck is located on top of and to the port side of the accommodation area at the stern of the FSRU away from hazardous equipment areas and in proximity to the FSRU's hospital/treatment room and crew accommodation area, which is also the prime temporary refuge location in the event of an emergency. The helideck is located to provide the optimum position for helicopter operability. One complete set of helicopter lights and an illuminated windsock will be provided in accordance with Civil Aviation Authority (CAA) requirements for day and night operations.

Broadwater has coordinated with the Federal Aviation Administration (FAA) to understand the requirements associated with review and approval of the helipad that will be sited on the FSRU. Through the consultation process with FAA, it has been determined that Broadwater will need to submit a Form 7480-1, Notice of Landing Area Proposal. Upon receipt of the Form 7480-1, FAA will make an assessment of potential impacts of the helipad in its current location. This assessment will focus primarily on an analysis of the helipad's proposed landing area and the impact of the helipad on existing air traffic in the region. Because the helipad located on the FSRU will be used only for emergency situations, it is not anticipated to have any impact on existing air traffic in the Long Island Sound region. Form 7480-1 will be submitted to the FAA in the next two weeks.

Broadwater representatives have been unsuccessful in their attempts to contact the New York State Department of Transportation regarding NYSDOT permitting requirements, if any, for the proposed Project. Within NYSDOT, the Project has been reassigned from the Highway Maintenance Division to the Division of Planning and Program Management. Attempts to contact the Division Director to discuss any permitting requirements NYSDOT have also been unsuccessful.

Broadwater does not understand its project to be subject to any requirements of Suffolk County due to the apparent absence of any applicable county law, the distance of the FSRU from shore and the provisions of the Natural Gas Act. Without waiver of this

EIR2-2

analysis, Broadwater is prepared to provide information to New York State and local agencies concerning the heliport and its intended limited operations.

EIR2-3

Request:

Since Long Island Sound is considered an inland water of New York, provide a justification for why the proposed pipeline should be classified as Class 1 under 49 CFR 192.3.

Response:

The connecting pipeline system will be designed in accordance with Part 192, Title 49, "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards" (latest edition) of the Code of Federal Regulations (CFR).

Long Island Sound is a unique body of water that the Supreme Court has determined to be an "inland water" of the United States and an historical bay, even though the Sound is bounded in part by an island rather than a continuous coastline. United States v. Maine, et al, 469 U.S. 504, 519 (1985) (commonly referred to as the Rhode Island and New York Boundary Case). However, the Sound's designation as an "inland water" does not alter the most appropriate classification of the proposed pipeline under 49 CFR Part 192, which has only 4 class designations for safety purposes. 49 CFR § 192.5. Class 1 is an offshore area. 49 CFR § 192.5 (b)(1)(i). Classes 2 through 4 cover all other "class location units," defined as **onshore** areas with various numbers of buildings intended for human occupancy. 49 CFR § 192.5 (a)(1). The higher the number of buildings and the denser the occupancy, the higher the class designation. 49 CFR § 192.5 (b)(2)-(4). Therefore, the short answer as to why the pipeline should be classified as Class 1 is that Classes 2 to 4 are clearly inapplicable because they apply only to onshore pipeline facilities. We note that the substantive safety provisions throughout 49 CFR Part 192 treat pipelines located "offshore or in inland navigable waters" identically. Therefore, whether the appropriate designation is "offshore" or "inland water" makes no substantive safety difference, at least for purposes of application of Part 192. For example, "pipelines, including pipe risers, on each platform located **offshore** or in **inland waters** must be protected from accidental damage by vessels." 49 CFR § 192.317.

Broadwater has determined that Class 1 remains the appropriate safety designation for the proposed pipeline because no other Part 192 designation fits, even though the definition of "offshore" technically excludes all waters in Long Sound. 49 CFR § 192.3.

EIR2-4

Request:

Clarify whether ballast water in the YMS would ever be drained during the life of the project. In the event that it would be drained, describe any environmental impacts of discharging the YMS ballast water including the concentrations and treatment of the water due to the presence of corrosion inhibitors.

Response:

There are no planned events/activities (maintenance or inspection) that will require the routine removal of the ballast in the YMS. The ballast water in the YMS is not required to be drained through the life of the project. A release of YMS ballast water would only occur if there was an accidental release from the YMS ballast tank caused by an external rupture.

The ballast is planned to be a mixture of freshwater and glycol that is designed to inhibit corrosion in the tank and also to prevent it from freezing. The design of the tank consists of a series of compartments, each of which is watertight and independent from each other. (The number and size of compartments to be determined during detailed engineering of the system.) The compartments will be internally coated to prevent corrosion, and will have no internal piping. The only appurtenance will be a single watertight manhole located at the very top of each compartment.

Glycol in a concentrated form can impact water quality and can be potentially harmful to humans and fish. However, the glycol/water mix that will be present in the YMS will be dilute and, if released, would quickly assimilate and mix with the surrounding water. Glycol is highly biodegradable in natural systems at low concentrations and exposure to oxygen in the water column will aid in its quick breakdown.

Request:

We received comments from another agency regarding the frequency, extent, and magnitude of pipeline movement along the expansion spool. Describe this movement and any potential impacts to the seafloor and associated biological communities.

Response:

Broadwater Pipeline LLC's FERC application, Exhibit G-II: Engineering Design Data Used in Exhibit G and G-1, states that the vaporized LNG maximum sendout temperature is 120°F at the base of the mooring tower riser, and that the winter ground temperature is 40°F. The thermal stresses produced by this 80°F temperature differential necessitates the introduction of an expansion loop of specific geometry to cause the stresses in the pipeline to be within acceptable limits as defined by the ASME B31.8 code allowable limits.

A preliminary stress analysis was completed using the pipe stress software package CAESAR II. Initially, simple tie-in configurations were created at the ends of the pipeline along with minimum burial requirements that revealed the potential for overstressing the pipeline at the FSRU end of the pipeline. Various spool piping configurations, including expansion loops, along with deeper burial depths were analyzed in successive iterations to reduce pipe stresses and converge on an acceptable preliminary design.

The gradual movement of the expansion loop will be minimal and isolated in the piping near the expansion loop bends. The initial pipeline movement will be during the start up of the facility when the pipeline is loaded with warmed natural gas. The magnitude of movement at the expansion loop bends is predicted from the stress analysis to approach one pipe diameter, but less movement is anticipated in practice due to restraints imposed by the application of high density concrete weight coating and mechanical backfill to the expansion loop (see below). Furthermore, the Broadwater Project is intended for continuous commercial operation so the temperature of the natural gas in the pipeline will not fluctuate significantly contributing to a relatively steady state condition in the pipeline system. Therefore, movements, albeit minor, due to thermal expansion will occur infrequently during normal operations.

The expansion loop geometry offers the required flexibility for thermal stresses to be distributed along the spool piping and to be reduced below allowable limits. The use of high density concrete weight coating and the addition of 5-feet of mechanical backfill will help restrain the pipeline by adding a larger normal force to the pipe-to-soil interaction and by adding overburden on the pipeline, respectively, which helps reduce spool deflections and therefore reduces stresses. This restraint of the pipeline will be enhanced over time with increasing embedment of the pipeline in the bottom of its trench and with backfill consolidation. Any movement that occurs should not be discernable from the seabed surface. Impacts to the seafloor and associated biological communities due to thermal expansion and movement of the pipeline, if any, will be negligible.

EIR2-6

Request:

Clarify the basis for Broadwater determining that the use of mid-line buoys on all construction vessel anchor lines would double the construction schedule, and present the expanded construction schedule.

Response:

Broadwater's response to the Commission's Environmental Information Request No. 5, issued March 31, 2006 stated that utilizing mid-line buoys on all laybarge anchor lines during pipe lay and lowering operations would provide for only a further 15% reduction in temporary seabed impact compared to mid-line buoys on the quarter anchor lines only. The premium for this modest reduction in cable sweep acreage includes, among other things, a significant increase in the construction schedule over the schedule with the use of quarter anchor mid-line buoys only. The increase is attributable to the extra time required to set, move and re-set the additional anchors during laybarge operations.

The schedule for the main pipe lay is October 2009 through April 2010. During this period, commencing with laybarge mobilization at the end of November 2009, the lay barge will complete laying the pipeline, followed by pipeline lowering. The lay barge will also install the IGTS hot tap connecting spool, and the downstream FSRU tie-in spool.

The following table illustrates the impact of using mid-line buoys on the laybarge operating schedule:

Table EIR 6-1 Comparison of Laybarge Operating Schedules

Laybarge Operations in Long Island Sound	No Midline Buoys		Midline Buoys on Qtr Anchor Lines		Midline Buoys on All Anchor Lines	
	Start	Finish	Start	Finish	Start	Finish
Mobilize to Work Site and Complete Pipe Lay Operations	28-Nov	08-Jan	28-Nov	12-Jan	28-Nov	16-Jan
Mobilize & Test Subsea Plow, Complete 2 Lowering Passes, and Demobilize Plow	09-Jan	18-Feb	13-Jan	26-Feb	17-Jan	06-Mar
Install Tie-in Spools and Demobilize from Work Site	19-Feb	28-Feb	27-Feb	09-Mar	07-Mar	18-Mar
Duration of Laybarge Ops	93 days		102 days		111 days	
Extension in Laybarge Ops (not including mechanical and weather downtime)	N/A		9 days		18 days	

EIR2-7

Request:

Quantify the seafloor acreage impacted by both the anchor footprints and anchor cable sweep during YMS installation.

Response:

A heavy lift crane barge will be used to install the mooring tower. A crane barge typically holds station (but is not propelled) with anchors thus there is only minor disturbance of the seabed due to touchdown of the slack cable during anchor deployment and there is no anchor line sweep. Assuming an 8 point anchor set is used to hold station during work at the yoke mooring system, the seafloor area impacted by anchor footprints is estimated at less than half an acre.

EIR2-8

Request:

Update the annual estimates of ichthyoplankton loss associated with operational water intake based on results from the October 2005, February 2006, and March 2006 site-specific field surveys. Provide the March 2006 results including the field results, density, and estimated daily loss due to impingement and entrainment.

Response:

Sampling results for March 2006 ichthyoplankton survey completed for the Project are presented in detail in the attached letter report. This report addresses not only the March data but also updates the annual entrainment estimates based on both the Poletti sampling program, which covered a period from March into early April, and the supplemental sampling conducted by Broadwater covering the timeframe of August 2005 through March 2006. The results are summarized below.

March 2006 Results

Results for the last site-specific survey period of March 2006 are presented below in Table 1. In general during this period, overall ichthyoplankton diversity was low and fourbeard rockling eggs were abundant and comprised over 99% of all eggs collected. American sand lance was the most abundant larvae taxa collected and accounted for over 66% of the total. Winter flounder were the second most abundant larvae collected and accounted for about 33% of the total. No young of the fish were collected.

Table 1. Average density (#/100m^3) of fish larvae (± standard deviation) collected during day (n=3) and night (n=3) tows from the mid-depth strata in the vicinity of the proposed Broadwater FSRU on March 28, 2006.

Species	Stage	Average Density (#/100m^3) ± stdev	Daily Entrainment Estimate	95 % Confidence Intervals
American sand lance	PYSL	8.32 ± 15.30	8,878	0-21,944
fourbeard rockling	Egg	151.81 ± 113.98	162,054	64,699-259,408
rock gunnel	PYSL	0.45 ± 0.69	475	0-1,064
windowpane	Egg	0.45 ± 0.70	479	0-1,073
winter flounder	YSL	2.22 ± 1.97	2,368	689-4,047
	PYSL	2.29 ± 2.42	2,441	371-4,511
yellowtail flounder	Egg	0.22 ± 0.54	235	0-695

* Daily entrainment estimates were determined by multiplying the average density by the average daily withdrawal by the FSRU and associated LNG carriers (28.2 MGD, 106,750 m^3/day).

EIR2-8

Annual Estimates of Ichthyoplankton Loss

The annual estimate of ichthyoplankton loss associated with operational water intake at the FSRU is based on the results from site-specific data collected in August and October of 2005 and February and March 2006. This data represents the interval of August to March over the course of a full year. To account for the interval of March to August, ichthyoplankton data collected as part of the Poletti 2002 sampling program was utilized, thus creating a dataset that can provide annual estimates for the entire year based on two intervals of 8 months and 6 months with some overlap that was accounted for when the numbers were combined and evaluated. The examination of these two datasets resulted in a value for each survey interval that represents the sum of egg and larval entrainment for that period. It is important to note that for each survey, different diel periods (day and night) were sampled and for the Poletti data, different depths (intermediate and deep). In order to represent the most conservative and "worst-case" scenario for potential ichthyoplankton loss, the highest entrainment values for the different diel periods and different depths are presented in this analysis. These numbers are presented below.

Entrainment Estimate (millions)		
	Eggs	Larvae
August - March	9.2	61.3
March - August	92.7	111.8

Based upon these entrainment estimates for each survey interval, the annual estimate of ichthyoplankton loss associated with operational intake would equal 101.9 million eggs and 173.1 million larvae as presented below.

Entrainment Estimate (millions)		
	Eggs	Larvae
Annual Loss	101.9	173.1

May 11, 2006
Ref No. 20546.000

Mike Donnelly
Ecology and Environment, Inc.
Buffalo Corporate Center
368 Pleasant View Dr.
Lancaster, NY 14086

RE: Letter Report summarizing the results of ichthyoplankton sampling in the vicinity of the proposed Broadwater FSRU. Sampling event No. 4, March, 2006.

FIELD METHODS

Normandeau Associates, Inc. (Normandeau) conducted ichthyoplankton sampling in the vicinity of the proposed Broadwater Energy floating storage and regasification unit (FSRU) in the Central Basin of Long Island Sound on March 28, 2006. Sampling was attempted the previous week but was postponed due to the unavailability of an observer from the Lobsterman Association and rough sea conditions. A one by one nautical mile square block centered on the location of the proposed FSRU facility was designated as the sampling area. Three random stations were selected within the sampling area using the Random Point Generator extension in Arcview (Figure 1). At each station the water column was divided into three depth strata based on an assumed depth of about 95 feet: near surface (0-30 feet), mid-depth (35-65 feet), near bottom (bottom, 70-95 feet). One ichthyoplankton tow was collected in each depth stratum of each station during daylight (defined as occurring between 1 hour after sunrise and 1 hour before sunset) and the daytime sampling was repeated again at night at the same three stations (defined as occurring between 1 hour after sunset and 1 hour before sunrise). A total of 18 valid samples (3 stations x 3 depths x 2 diel periods, Table 1) were collected on March 28, 2006 between 12:00-3:30 PM (day) and 7:00-10:00 PM (night).

All samples were collected with a 1.0 m^2 Tucker trawl with a 0.335 mm net and an 8:1 length to mouth ratio. The tucker trawl has a closing device that uses a double-trip release mechanism and a weighted lead bar to close the mouth of the net and insure that each sample is collected in each of the three discrete depth strata. Net towing speed was approximately 1.0 m/sec and tow duration was 5 minutes. A flume-calibrated digital flowmeter (GO Model 2030R) was placed in the mouth of the Tucker trawl to measure the distance (volume) of each tow. Tow depth was determined in the field using a cosine function relating wire length and wire angle to sampling depth. Tow volume was approximately 300 m^3 and ranged from 224-319 m^3 (Table 1). The start and end of each towpath was recorded using GPS. Samples were fixed at sea in 4% buffered formaldehyde and changed over to 80% ethanol within 18 hours. A conductivity, salinity, temperature, and dissolved oxygen profile was made at 5 foot intervals from one foot below the surface to one foot above the bottom at each of the three stations and two diel periods (6 total profiles) using a YSI Model 85 meter.

LABORATORY METHODS

Samples were sorted under magnification to remove all fish eggs, fish larvae, and lobster larvae which were then enumerated and identified to the lowest possible taxon (generally genus and species). Samples were further identified into the following life stages: egg, yolk-sac larvae and post yolk-sac larvae.

The accuracy of identifications, assignment to life stage, and counting was monitored and controlled by QC checks. A subset of the samples were randomly selected for re-identification by a quality control inspector according to a "10% AOQL" continuous sampling plan. This insured that at least 90% of the samples met specifications, because if any samples failed QC checks, data from those samples were corrected and the proportion of samples checked was increased. A sample failed identification QC if the original identifier's count differed from the QC inspector's count by 10% or more (or by more than two if the QC total was 20 or less). This acceptance criterion was applied separately by life stage to each taxon. An additional requirement for a sample to pass was that for each taxon, the sum of the percent errors for all life stages was required to be less than 10%.

RESULTS

Physical Profiles of Water Column

Water temperature, dissolved oxygen, and salinity were similar among the three stations (Table 2, Figures 2-4). Water temperature ranged from 3.7-5.4 °C, dissolved oxygen from 10.3-11.2 mg/l, and salinity 25.5-26.8 $^{o}/_{oo}$. At all three stations, the water column was relatively homogeneous although a slight (1°C) thermocline was apparent as the surface layers (0-20 ft) are being heated by increasing solar radiation. A spring zooplankton bloom was apparently occurring on March, 28 as large concentrations of the copepod *Temora longicornis* and to a lesser extent *Acartia hudsonica* were present throughout the water column.

Total Species Composition

Overall ichthyoplankton diversity was low. Fourbeard rockling (*Enchelyopus cimbrius*) eggs were abundant and comprised over 99% of all eggs collected on March 28, 2006 (Table 3). Windowpane (*Scophthalmus aquosus*) and yellowtail flounder (*Limanda ferruginea*) eggs were collected in low concentrations. American sand lance (*Ammodytes americanus*), winter flounder (*Pseudopleuronectes americanus*), rock gunnel (*Pholis gunnellus*), and grubby sculpin (*Myoxocehpalus aenaeus*) were the only larvae collected during sampling on March 28, 2006 (Table 3). American sand lance were the most abundant larvae taxa collected and accounted for over 66% of the total. Winter flounder were the second most abundant larvae collected and they accounted for about 33% of the total. Both yolk-sac and post yolk-sac winter flounder larvae were observed (Table 3). Rock gunnel and grubby larvae were collected in low concentrations and accounted for 2.7% and 0.5% of the total number of larvae collected respectively. No young of the year fish were collected.

Many aspects of the morphology and ecology of *Ammodytes* spp. along the east coast of the United States are potentially confounded by taxonomic problems differentiating between the American or inshore sand lance (*A. americanus*) and the offshore sand lance *A. dubius* (Nizinski et al. 1990). Because most estuarine collections of *Ammodytes* are *A. americanus* (Able and Fahay 1998) and *A. americanus* predominates in Long Island Sound (Monteleone et al. 1987), *Ammodytes* larvae were assumed to be *A. americanus.*

Ichthyoplankton Density Across Diel Period and Depth Strata

A two-way ANOVA on log (x+1) transformed density (#/100m^3) did not detect a significant difference between the two diel periods or three depth strata for fish eggs collected on March 28, 2006. Egg density was dominated by fourbeard rockling which had a relatively even distribution throughout the water column during both diel samples (Table 4, Figure 5A). Larvae (yolk sac+post yolk sac stages) density was significantly higher at night ($p< 0.01$), however there was no significant difference between the three depth strata as determined from a two-way ANOVA on log (x+1) transformed data. Larvae collections were dominated by sand lance which were more abundant in the surface collections and by winter flounder which were relatively uniform throughout the water column during day and night (Table 5, Figure 5B).

Ichthyoplankon Community Similarity Across Diel Period and Depth Strata

Community similarity between the two diel periods and three depth strata was evaluated through ordination using non-metric multidimensional scaling (NMDS). Analysis was based on the Bray-Curtis similarity index generated from all pairwise sample comparisons on 4th root transformed egg and larval (yolk-sac + post yolk-sac stages) densities. Like all multivariate techniques, NMDS is based on a similarity coefficient matrix calculated between every pair of samples. The Bray-Curtis similarity values were then transformed to ranks (the highest similarity between a pair of sites has the lowest rank, 1, and the lowest similarity has the highest rank, (n(n-1)/2). NMDS then constructs a "map" or configuration of the samples. The NMDS map is constructed to preserve the similarity ranking as Euclidean distances on the two dimensional plot and attempts to satisfy all conditions imposed by the rank similarity matrix, e.g. if sample 1 has higher similarity to sample 2 than it does to sample 3 then sample 1 will be placed closer on the map to sample 2 than it is to 3. The principle of the NMDS algorithm is to choose a configuration of points which minimize the degree of *stress* or distortion between the similarity rankings and the corresponding distance rankings in the ordination plot. The stress value provides a "goodness of fit" measure, in general, stress < 0.05 gives an excellent representation with no prospect of misinterpretation, stress < 0.1 corresponds to a good ordination with no real prospect of a misleading interpretation, and stress < 0.2 still gives a potentially useful 2-dimensional picture, though for values at the upper end of this range too much reliance should not be placed on the detail of the plot (Clarke and Warwick 1994). NMDS is based on rank order about which samples are most or least similar, axes are non-metric and the ordination plot can say nothing about which direction is "up" or "down", or the absolute "distance apart" of two samples, what can be interpreted is relative distances apart (Clarke and Warwick 1994). NMDS can be recommended as one of the best (arguably the best) ordination technique available (Everitt 1978, Clarke and Warwick 1994). The few comprehensive studies that have compared ordination methods for community data give NMDS a high rating (Kenkel and Orloci 1986).

Because 99.8% of the eggs collected on March 28, 2006 were fourbeard rockling the NMDS analysis was primarily influenced by differences in abundance in fourbeard rockling eggs. It is apparent from Figure 5A that fourbeard rockling were distributed relatively uniformly throughout the water column during both diel periods and therefore there is no apparent clustering of samples in the NMDS ordination plot for eggs (Figure 6). The larval fish community also had low diversity (4 taxa) and was dominated by sand lance, and to a lesser extent winter flounder. Therefore the results of the NMDS are largely driven by differences in abundance of sand lance and winter flounder larvae. Figure 7 suggests a general separation of daytime mid-depth and bottom tows from nighttime and daytime surface tows. This is most likely due to the prevalence of winter flounder larvae in the mid-depth and bottom collections during daytime and the prevalence of sand lance larvae in the daytime surface and nighttime collections (Figure 5B, Table 5).

Impact Analysis Based on Ichthyoplankton Densities Collected on March 28, 2006

The average density (#/m^3) for eggs and larvae collected from the mid-depth strata on March 28, 2006 during daytime sampling (n=3) and during nighttime sampling (n=3) was multiplied by the average daily water intake of the FSRU and associated LNG carriers (106,750 m^3/day, 28.2 million gallons/day) to estimate daily entrainment rates for species and life stage (Table 9) because water intake locations will be located at 35-45 feet below the water's surface. The patchy distribution of ichthyoplankton resulted in a relatively high standard deviation between the samples and wide confidence intervals for the entrainment estimates. Three species of fish larvae (sand lance, winter flounder, rock gunnel) and three egg taxa (fourbeard rockling, windowpane, yellowtail flounder) were collected from the mid-depth strata. Fourbeard rockling eggs were the dominant ichthyoplankton and the daily entrainment estimate based on mean density in the mid-depth strata from collections on March 28, 2006 was about 162,000 (Table 9). Sand lance and winter flounder were the most abundant larvae with daily entrainment estimates based on mean density of about 9,000 and 5,000 respectively. Entrainment rates for winter flounder yolk sac and post yolk sac larvae were roughly equivalent (Table 9).

Entrainment estimates from Table 9 were expressed in terms of Age 1 fish using the Equivalent Adult Model. The Equivalent Adult Model (EAM) is an estimation method for expressing ichthyoplankton entrainment losses as an equivalent number of individuals at some other common life stage, referred to as the age of equivalency (Goodyear 1978). The method provides a convenient means of converting estimated losses of fish eggs and larvae into units of individual fish and provides a standard metric for comparing losses among species, years, and facilities (EPA 2004). The age of equivalency can be any life stage of interest. For the 316 (b) cooling water intake case studies, EPA (2004) expressed impingement and entrainment losses as an equivalent number of Age 1 individuals (the Age 1 fish considered in this analysis are typically less than 6 inches in length).

The EAM calculation requires life-stage specific entrainment counts and life-stage specific mortality rates from the life stage of entrainment to the life stage of equivalence. The losses at any given stage are multiplied by the fraction of fish at that stage or age that would be expected to survive to the age of equivalence:

$$EA = S_A N$$

Where: EA = equivalent age 1 loss, N= number of fish lost due to entrainment, S_A= fraction of fish expected to survive from the age at which they are entrained to the age of equivalence.

Survival rates of early life stages of fish are often expressed on a life-stage specific basis so that the fraction surviving from any particular life stage to the age of equivalency is expressed as the cumulative product of survival fractions for all of the life stages through which a fish must pass before reaching the age of equivalency. One of the benefits of this model is that it can be used to express losses imposed on different lifestages in common equivalent units.

$$EA = \bullet \bullet S_{i,a} N_i$$

Where:

N_i= number of fish lost at age i

$S_{i,a}$= fraction of fish expected to survive from age i to the age of equivalence

Instantaneous total mortality (Z) is the sum of mortality from natural causes (M) and mortality from recreational and commercial fishing (F), (Z = M+F). Fishing mortality is zero for Age 1 fish species collected during sampling on March 28, 2006, therefore Z=M. Survival rate (S) is the estimated proportion of a lifestage that survives from the beginning to the end of that stage ($S = e^{-Z}$). It was conservatively assumed that no eggs or larvae survived entrainment and no larvae were able to actively avoid the intake.

The probability that a fish entrained at any given life stage would have survived to the age of equivalence is greater if the fish is near the end of that stage than if it at the beginning of the stage, because it would have already survived most of the natural mortality that occurs during that stage. Therefore, to find the expected survival rate from the day that a fish is entrained until the time that it would have passed into the subsequent age, an adjustment to S_i is required. The adjusted rate S^*_i describes the effective survival rate for the group of fish entrained at stage i considering the fact that the individual fish were entrained at various ages within stage i. This adjustment is applied only to the stage at which entrainment occurs, the unadjusted survival rate would be applied to subsequent lifestages until the age of equivalency (Age 1).

$S^*_i = 2S_i e^{-\ln(1+Si)}$ (EPRI 2003, EPA 2004)

Lifestage specific mortality rates were obtained from EPA (2004) values used to evaluate impingement and entrainment in the Mid-Atlantic (http://www.epa.gov/waterscience/316b/casestudy/final/appd1.pdf) and North-Atlantic Region (http://www.epa.gov/waterscience/316b/casestudy/final/appc1.pdf) because location specific mortality rates are not available. The entrainment estimates for fish eggs and larvae in Table 9 were expressed in terms of Age 1 equivalents using the survival rates obtained from EPA (2004) in Table 10. For example, the daily entrainment estimate of 8,879 sand lance larvae is multiplied by the adjusted survival rate for the larval stage (0.10) resulting in an estimated 888 fish expected to survive until the end of the larval stage from the original 8,879 entrained. Of these 888 fish entering the juvenile stage, only 49 would be expected to survive natural mortality during that stage with S= 0.06. Therefore, 49 of the original 8,879 sand lance larvae entrained would be expected to survive to the beginning of Age 1 based on these natural mortality rates.

Impact Analysis Based on Site-Specific Ichthyoplankton Densities Collected at the proposed Broadwater Location

Four site specific collections to date have been collected and enumerated (August 28, 2005; October 4, 2005; February 8, 2006; and March 28, 2006). A fifth collection was made on April 18, 2006, however these samples are still being processed in the laboratory. Details of each sampling event can be found in the individual letter reports. Mean ichthyoplankton density in the mid-depth strata was multiplied by the average daily withdrawal to estimate daily entrainment rates as previously discussed. The daily entrainment rates derived from ichthyoplankton density in the mid-depth collections on each of the four sampling dates are presented in Table 11. Daily entrainment rates were greatest in August (about 80,000 eggs and 680,000 larvae) and lowest in February (about 100 eggs and 10,000 larvae) reflecting seasonal changes in ichthyoplankton density (Figures 8,9). Estimated larval entrainment remained low in the March sample, however estimated egg entrainment rose noticeably due to increased density of fourbeard rockling eggs (Figure 9).

The daily entrainment rates from the four sampling dates were extrapolated based on regional seasonal occurrence patterns (i.e. Wheatland 1956, Monteleone 1992, Keller et al. 1999, Able and Fahay 1999) in order to provide an estimate of the total number of ichthyoplankton entrained from August 2005-March 2006. The August 28, 2005 sample was considered representative of the late summer-early fall assemblage from 1 August- 15 September; the October 4, 2005 sample represented the fall assemblage from 16 September-30 November; the February 8, 2006 sample represented the winter assemblage from 1 December-28 February; and the March 28, 2006 sample represented the late winter-early spring assemblage from 1 March-31 March. Daily entrainment estimates were summed for their representative periods and the estimated entrainment numbers from August 1, 2005-March 31, 2006 based on the four sampling events is provided in Table 12. For example, the daily entrainment estimate of Atlantic mackerel yolk-sac larvae derived from the August 28 sample densities is 356/day (Table 11); multiplying 356* 46 days = 16,376 mackerel yolk sac larvae entrained from August 1-September 15, 2005 (Table 12). Entrainment estimates are based (1) on the average of day and night collections and for (2) just night collections (larvae only) in order to address a potential bias of daytime sampling due to gear avoidance by larvae. Because eggs are not capable of gear avoidance, entrainment estimates are based on the mean of day and night samples. Entrainment estimates for eggs is about 9.2 million and estimates for larvae (YSL+PYSL) is about 36.7 million (day and night samples) and about 61.3 million (night samples only) during the August 1, 2005-March 31, 2006. period. The entrainment estimates for each species based on site specific sampling for August-March 2005/06 are provided alongside estimates of March-July, 2002 based on the Poletti Ichthyoplankton Program sampling in Long Island Sound (Table 13) as discussed in Normandeau 2006. Three different depth strata (total depth of the water column, not sample depth) were sampled in the Poletti Program: shallow (10-20 ft. total depth), intermediate (20-98 feet) and deep (>98 feet). Because the proposed FSRU location lies in about 95 feet of water, both the intermediate and deep Poletti strata were considered representative of the location (Appendix C, Normandeau 2006). Entrainment scenario # 1 applied to the Poletti data is based on unadjusted daytime samples with a tucker trawl. For entrainment scenario # 2 a diel correction factor was applied to bay anchovy and fourspot flounder larvae based on day-night differences in abundance based on comparison of Poletti (day only) and nighttime Hudson River Long River Survey in overlapping regions during comparable time periods as discussed in Appendix A of Normandeau (2006). Entrainment estimates based on the March-July, 2002 Poletti Program and the August-March, 2005-2006 site specific collections are summarized in Table 14.

Discussion

In summary, the ichthyoplankton community in the vicinity of the proposed Broadwater FSRU in the central basin of Long Island Sound during day and night sampling on March 28, 2006 was comprised of relatively few species and density was low compared to August and October (Figures 8,9). Ichthyoplankton diversity and abundance was considerably lower in the February 8, and March 28, 2006 samples than during the August 23, 2005 sampling event, reflecting the seasonality of the ichthyoplankton community in Long Island Sound typical of estuarine systems in the Mid-Atlantic Bight (Able and Fahay 1998). Ichthyoplankton abundance and diversity are low in the winter when few species spawn. Ichthyoplankton abundance and diversity begin to increase in the spring, and reach a peak during mid-late summer when many species reproduce. Ichthyoplankton abundance and diversity decline in the fall when spawning is curtailed (Able and Fahay 1998). There is a clear seasonal change in the ichthyoplankton community composition between the four site-specific sampling dates (Figures 8,9). August samples were composed of a relatively abundant and diverse community dominated by bay anchovy, searobin, smallmouth flounder and butterfish. In October samples, diversity and abundance were greatly reduced and the community was primarily Atlantic menhaden. The winter ichthyoplankton community represented by the February samples found no eggs in water column collections and low larval diversity dominated by American sand lance. The March collection represents the seasonal transition of the springtime ichthyoplankton community with the appearance of fourbeard rockling eggs and winter flounder larvae, although overall diversity and larval abundance remain low.

Egg collections were dominated by fourbeard rockling which were evenly distributed between the three depth strata. Fourbeard rockling was the most common egg in the Central Basin area of Long Island Sound during March and April 2002 collected during the Poletti Program (Normandeau 2006, Table 15). Only two fourbeard rockling eggs were collected during the February 8, 2006 sample suggesting that peak spawning had not yet occurred. During the Poletti program, fourbeard rockling eggs were present in low density at the start (March 4, 2002) of the program and peaked from mid-March though mid-April (Normandeau 2006). Fish egg abundance displayed a bi-modal peak during the March-July, 2002 Poletti ichthyoplankton program with a spring peak dominated by fourbeard rockling and a peak in June dominated by tautog, searobin, weakfish/scup, and Atlantic menhaden eggs (Normandeau 2006). Fourbeard rockling eggs comprised the overwhelming majority of eggs collected from March through mid-May when eggs of summer spawning species emerged in the Poletti collections (Normandeau 2006). Wheatland (1956) found fourbeard rockling eggs in Long Island Sound from March-June with peak density in April. Other species likely to spawn in the region during this time such as grubby, rock gunnel, and winter flounder, produce demersal eggs not likely to be present in the water column.

Fish larvae in collections on March 28, 2006 were composed of few species in lower overall densities than observed in August, 2005 (Figure 8). Four species of larvae (American sand lance, winter flounder, grubby, and rock gunnel) were collected. American sand lance (67 % of total) and winter flounder (33% of total) dominated the larval fish community. Sand lance were more abundant in the surface collections and at night, winter flounder was uniformly distributed throughout the water column.

Sand lance have a long spawning season, typically from November through March in Long Island Sound (Wheatland 1956, Monteleone et al. 1987). Incubation, hatch and larval duration and are particularly long for this species. Smigielski et al. (1984) incubated eggs in the laboratory at a range of temperatures (2, 4, 7, and 10 °C). Start of hatching ranged from 61 days (2 °C) to 25 days (10 °C) after fertilization. Larval collections in Long Island Sound indicate that sand lance hatching commences sometime in late November-early December, peaks from December through February when they are the dominant larval fish collected, and continues into March and April (Wheatland 1956). Monteleone et al. (1987) presented 17 years of data of American sand lance larvae in Long Island Sound collected over a 32 year interval and found approximately 94% of the annual catch of sand lance larvae occurred from December to March when water temperatures ranged from -1 to 12 °C. Sandlance density from daytime collections in the surface depth strata collected on March 28, 2006 (approximately 0.12/m^3, ± 0.14 standard deviation) are within the range of March densities given by Monteleone et al. (1987), although lower than her reported 32 year interval average of 2.2/ m^3. Density of larval sand lance collected in March was comparable to that of February, although nighttime collections in February demonstrated a greater proportion of the catch in bottom samples than observed in March. Monteleone et al. (1987) found large interannual fluctuations in density of sand lance larvae in Long Island Sound and hypothesized that this could be partially explained by water temperatures in December, with warm Decembers associated with low larval densities. Based on published information regarding sand lance seasonal occurrence in Long Island Sound and the long larval duration of this species, the densities (and therefore the daily entrainment estimates based on these densities) encountered on February 8, and March 28, 2006 are likely representative of the seasonal peak for sand lance larvae occurring from December-early April.

In the 2002 Poletti program, winter flounder larvae were present in Long Island Sound from mid-March to June (Normandeau 2006) and peaked during late March, they were not collected in early March. Bourne and Govoni (1988) found winter flounder larvae to be most common in shoal water, in or near coves and small bays and comparatively rare in deeper waters in Narragansett Bay. Pearcy (1962) found larvae most common from March to June in the Mystic River estuary and they were typically more abundant near the bottom. Whealand (1956) collected winter flounder larvae from March-May Long Island Sound, Keller et al. (1999) observed larvae from March-June in Narragansett Bay, and Monteleone (1992) observed larvae from March-April in Great South Bay, NY.

The four site specific samples collected in August, October, February, and March provide a snapshot of ichthyoplankton species composition and densities in the project area. The scheduling of sampling events was designed to address seasonal changes in ichthyoplankton species composition and abundance based on published regional surveys and known life history information (e.g. Wheatland 1956, Monteleone 1992, Able and Fahay 1999, Keller et al. 1999). Although a finer temporal sampling resolution is desirable for entrainment estimates due to the patchy and dynamic nature of ichthyoplankton communities, site-specific entrainment estimates based on the four sampling dates to date are presented in Table 12. The daily entrainment estimates (Table 11) obtained from the four sampling dates were extrapolated to address the entire August 1, 2005-March 31, 2006 period (243 days). The daily entrainment rate derived from the August 23 sample represents the August 1-September 15 late summer period (46 days) when the ichthyoplankton community is still relatively diverse and abundant but declining as water temperatures and productivity decline and summer spawning species grow and recruit to benthic habitats or move offshore to wintering grounds. The daily entrainment rate derived from the October 4, 2005 sample was extrapolated to represent the October 16-November 30, 2005 period (76 days). The ichthyoplankton community in the fall is greatly reduced and few species are spawning. Ichthyoplankton abundance is greatly reduced by November when few species are present. Atlantic menhaden larvae typically occur in the water column of Long Island Sound during two recruitment pulses, one in June-July and a second one in the fall (Wheatland 1956, NUSCO 2005). The October 4 sampling event was scheduled primarily to address the fall density of Atlantic menhaden eggs and larvae in the project area because this period was not sampled by the 2002 Poletti Program (March-July) and thus not included in the entrainment assessment based on the Poletti data (Normandeau 2006). Daily entrainment estimates derived from the February 8, 2006 sample was applied to the December 1-February 28 winter period (90 days). Although winter ichthyoplankton abundance in the mid-Atlantic Bight is typically low (Able and Fahay 1999), American sand lance larvae are present and often occur in densities rivaling the most abundant larval species on an annual basis (Wheatland 1956, Monteleone 1992, Chute and Turner 2001). Daily entrainment estimates derived from the March 28, 2006 sample were extrapolated to represent the March 1-March 31 period (31 days). The March sample was scheduled to address the persistence of larval sand lance in the water column and capture the emergence of larval winter flounder and fourbeard rockling eggs which were prominent in the Poletti samples and peaked in late March (Normandeau 2006). Entrainment estimates for the August 1, 2005-March 31, 2006 period based on site-specific sampling from day and night samples in the mid-depth strata (35-65 feet) on four dates is about 9.2 million eggs (55% fourbeard rockling, 24% bay anchovy) and 36.7 million larvae (79% bay anchovy). Entrainment estimates were also generated based on just nighttime samples for larvae to account for potential bias due to gear avoidance. Larval entrainment estimates for the August 1- March 31 period based solely on night samples was 61.3 million (85% bay anchovy).

The inclusion of the four site specific samples in August, October, February and March addresses the fall-winter gap in the entrainment analysis based on the Poletti data (March-July, 2002) provided by Normandeau (2006) and summarized in Table 14. The most conservative entrainment estimate for March-July based on the 2002 Poletti ichthyoplankton data is the intermediate depth strata with the diel correction factor applied to bay anchovy and fourspot flounder (Appendix C, Normandeau 2006). Under these assumptions, 92.7 million eggs and 111.8 million larvae would be entrained in the FSRU facility withdrawing 106,750m^3 per day from March through July (Table 14). The most conservative estimate for the August through March period is based on the site specific collections with only night samples considered for larval fish entrainment. The entrainment estimates based on the site specific collections from August 1-March 31, 2006 are 9.2 million eggs and 61.3 million larvae (Table 14).

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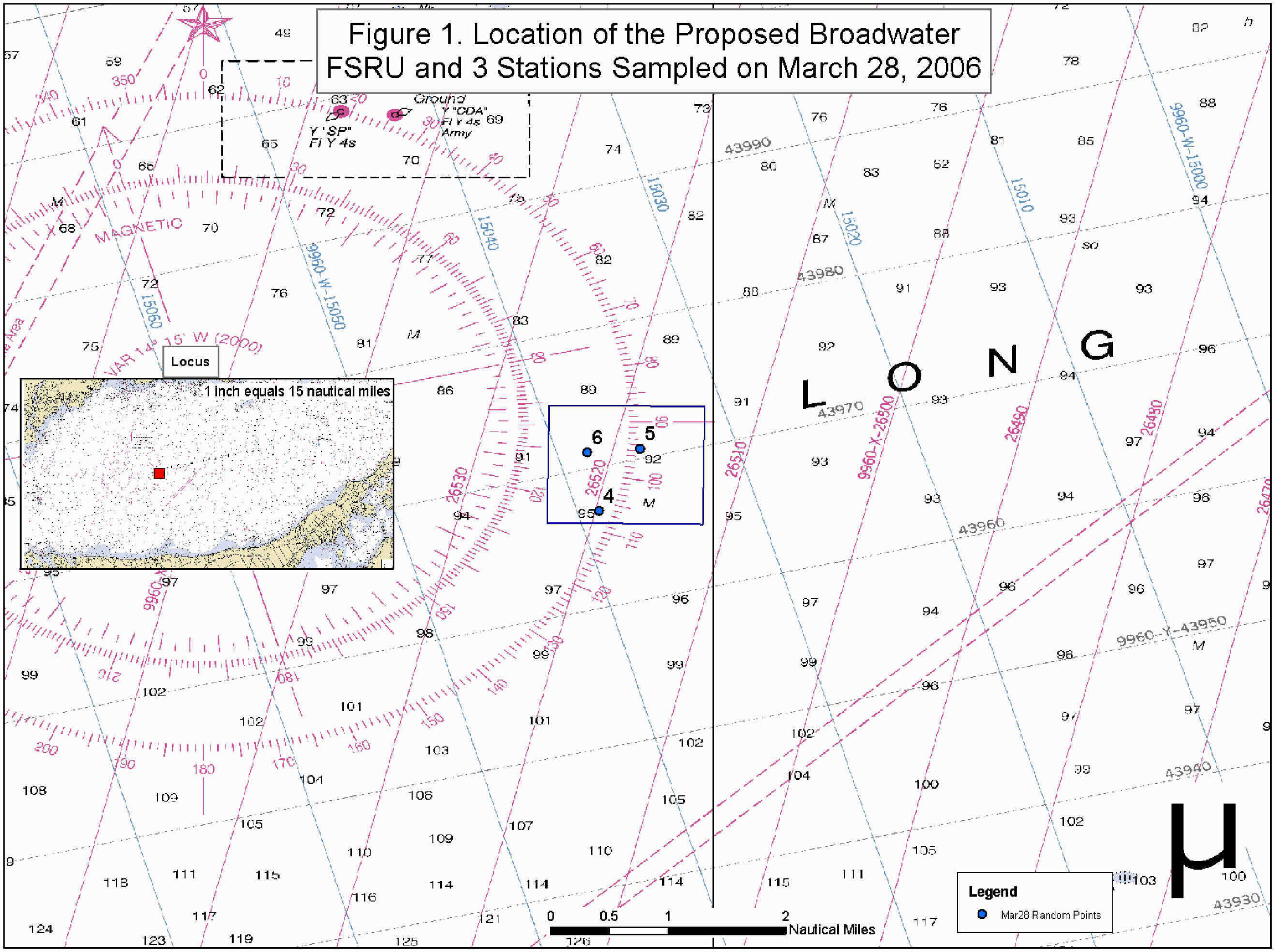


Figure 1. Three random sampling locations within a 1 nautical mile square block centered on the location of the proposed Broadwater FSRU sampled on March 28, 2006.

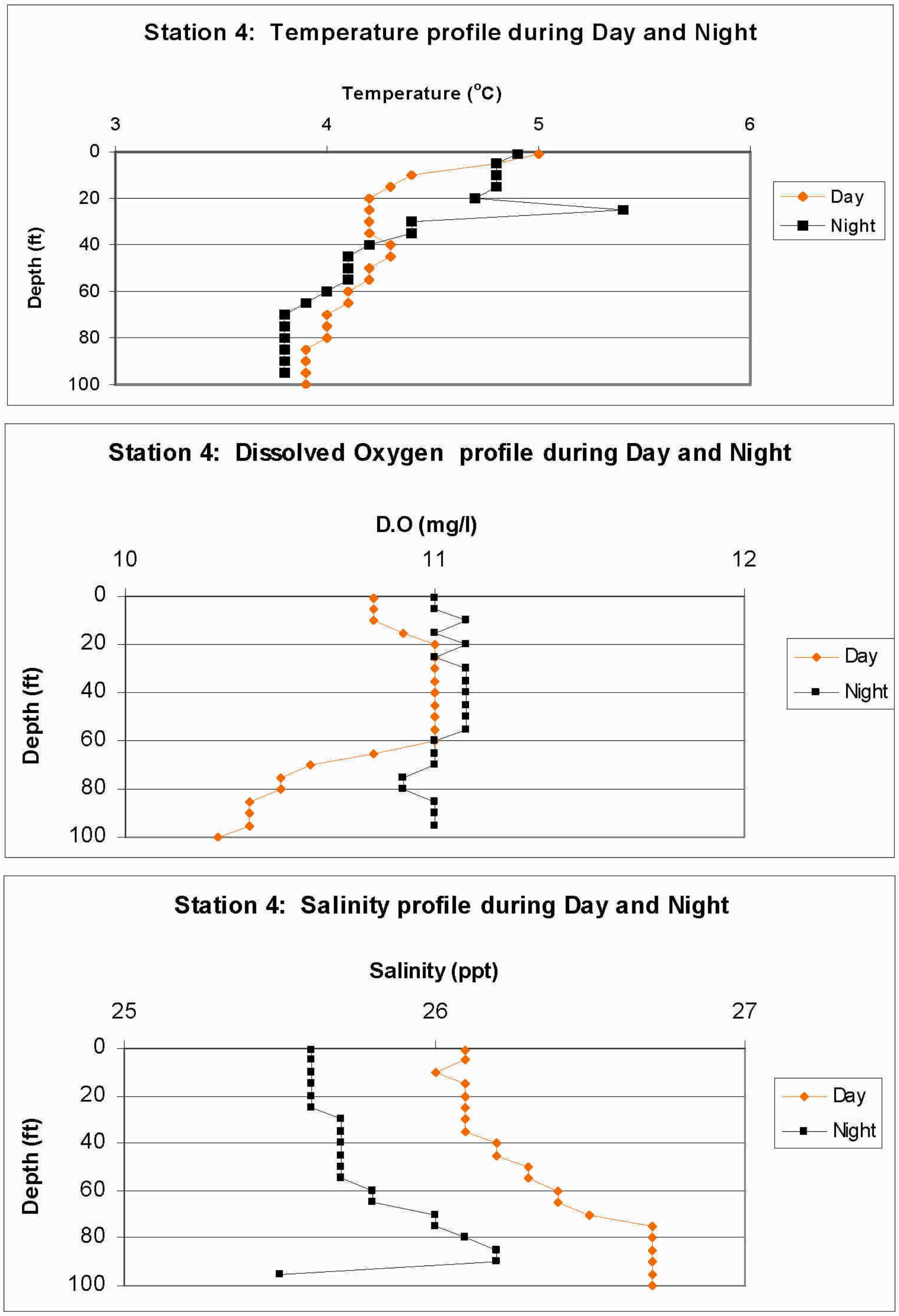
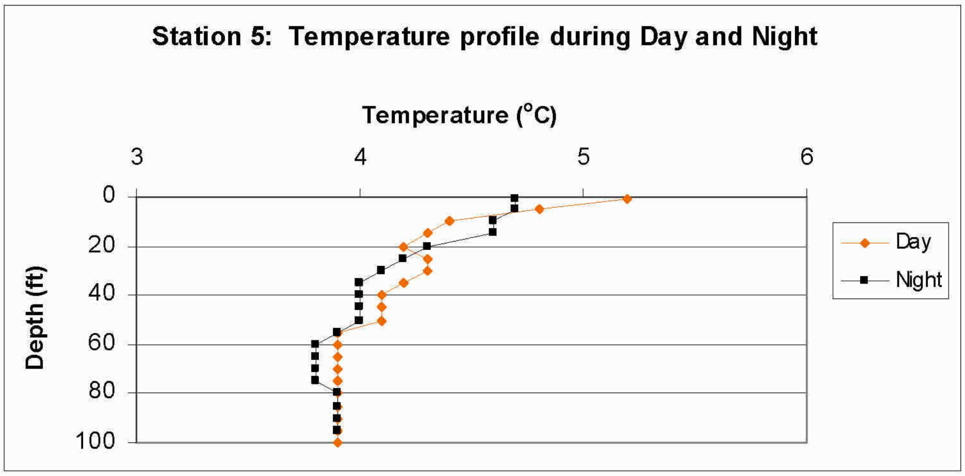
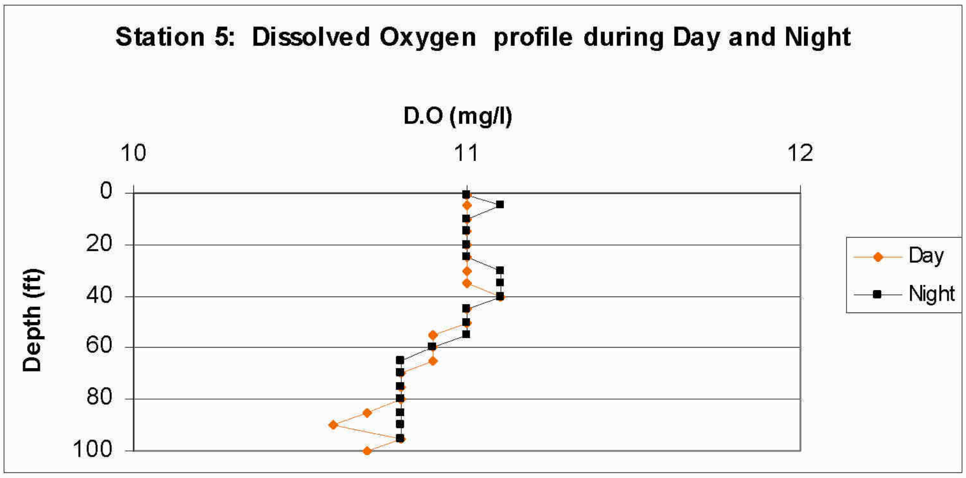


Figure 2. Physical profile (temperature, dissolved oxygen, and salinity) of the water column during Day and Night sampling at Station 4 on March 28, 2006.





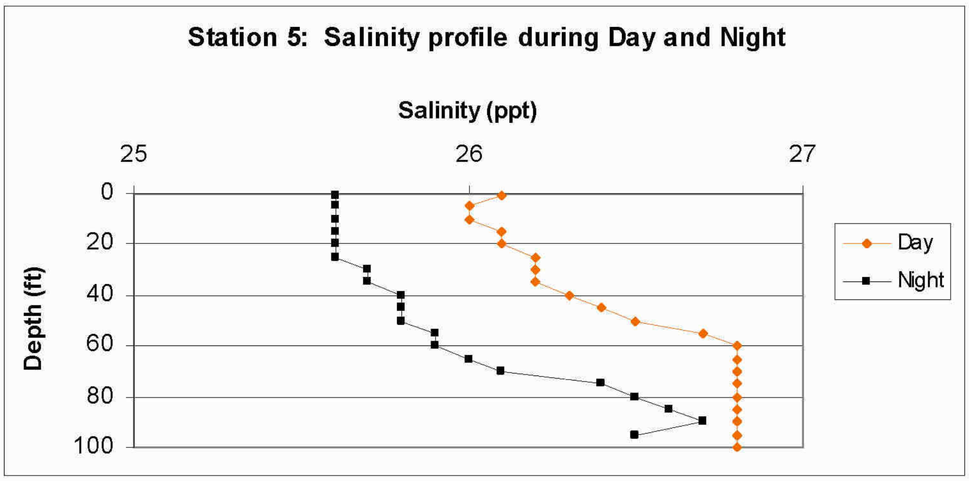
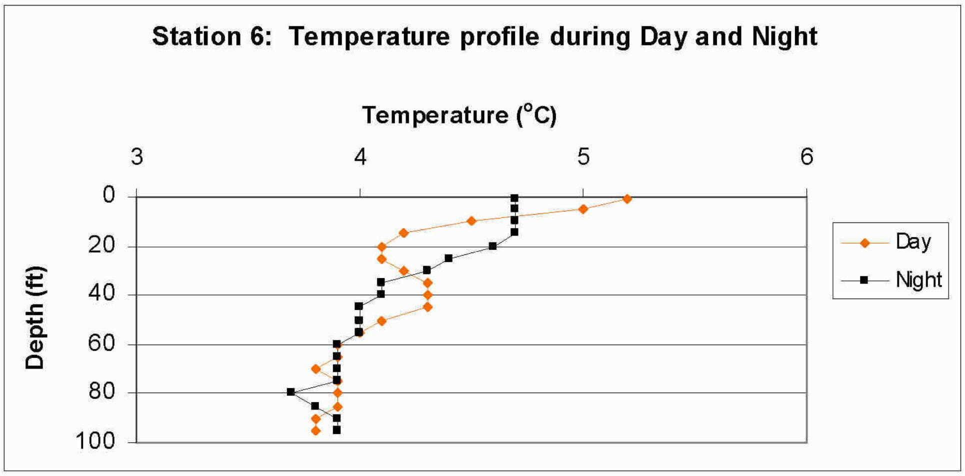
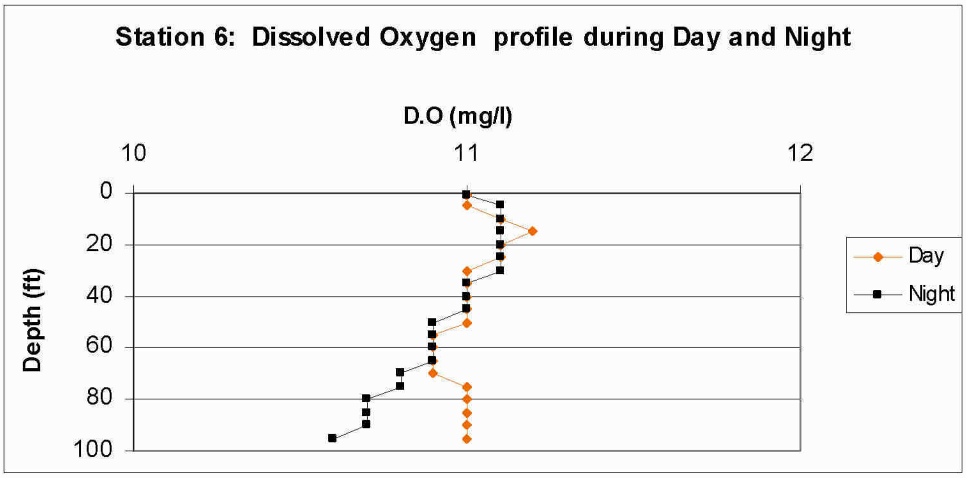


Figure 3. Physical profile (temperature, dissolved oxygen, and salinity) of the water column during Day and Night sampling at Station 5 on March 28, 2006.





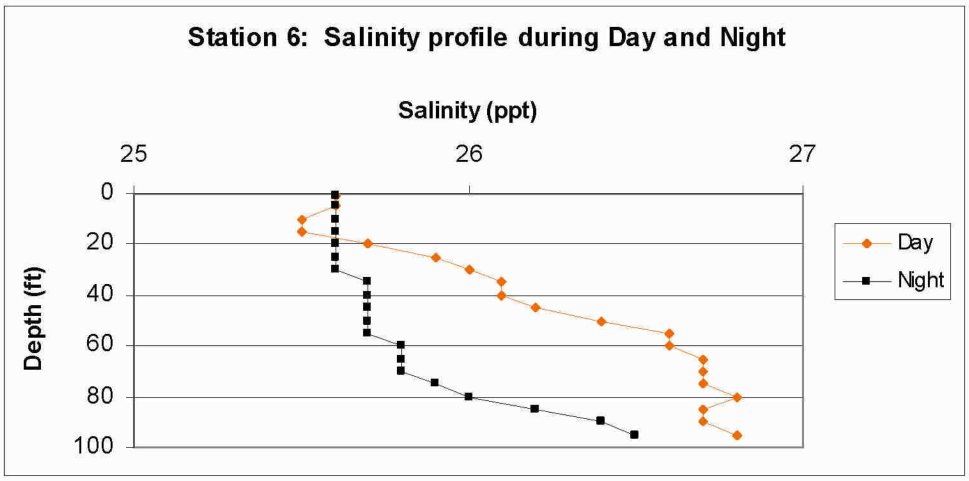


Figure 4. Physical profile (temperature, dissolved oxygen, and salinity) of the water column during Day and Night sampling at Station 6 on March 28, 2006.

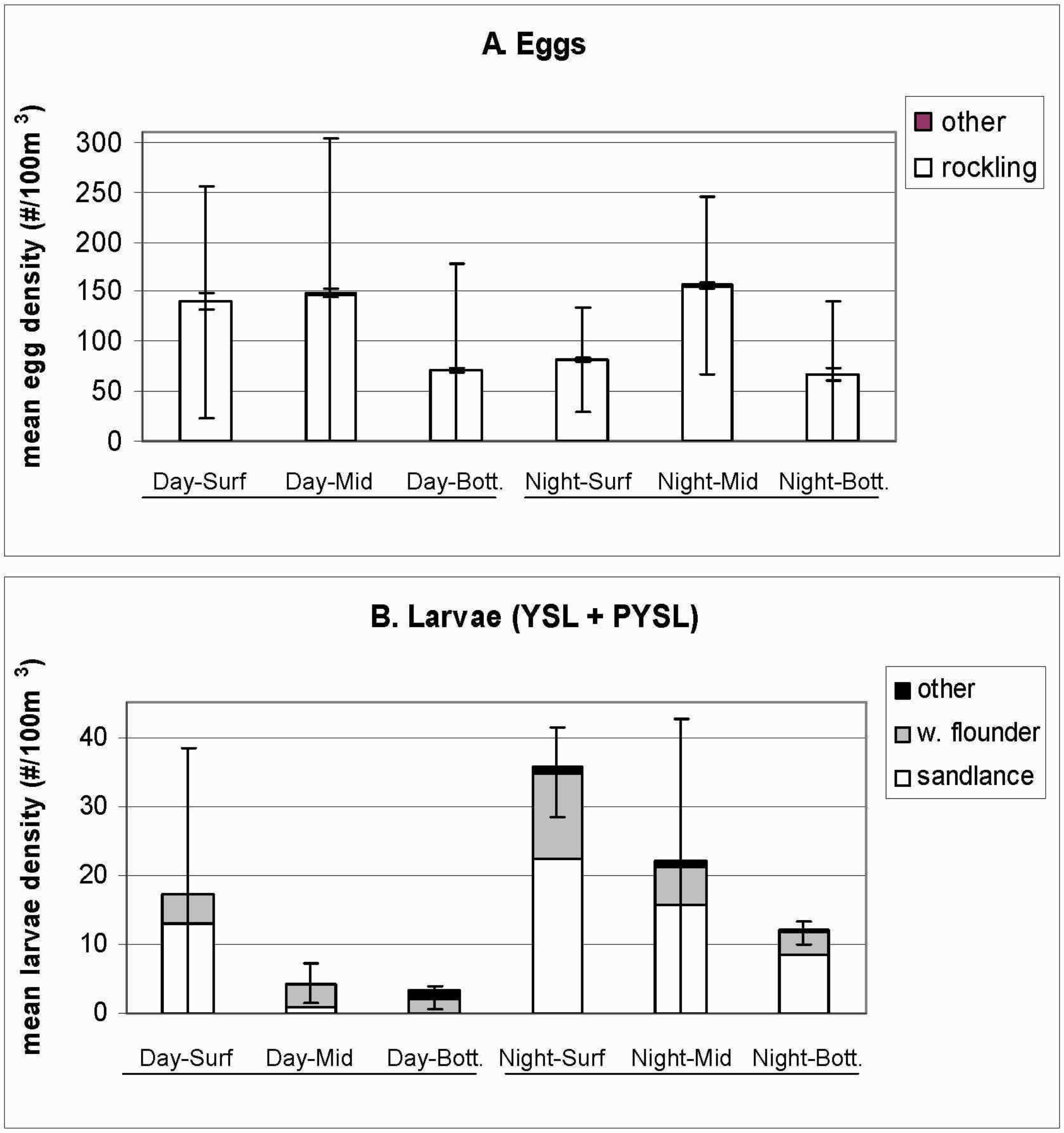


Figure 5. Mean (A) Egg and (B) larvae (PYSL+YSL) density (#/100m^3) and standard deviation from the three replicate tows conducted at the surface (0-30 ft), mid-depth (35-65 ft) and bottom (70-95 ft) strata during daytime and nighttime sampling in the vicinity of the proposed FSRU facility on March 28, 2006.

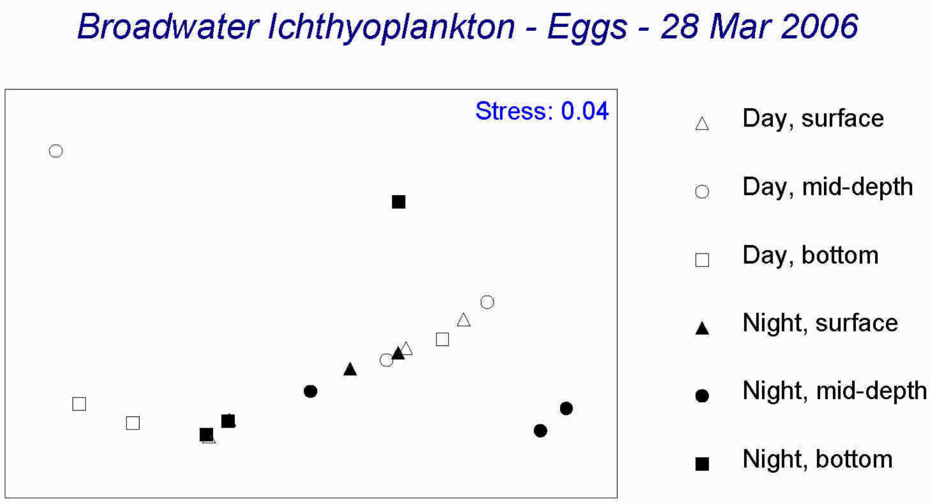


Figure 6. Non-metric multidimensional scaling ordination of 18 (3 replicate stations, 2 diel periods, 3 depth strata) samples collected on March 28, 2006 for 4th root transformed fish egg density (#/100m^3) based on Bray-Curtis similarities.

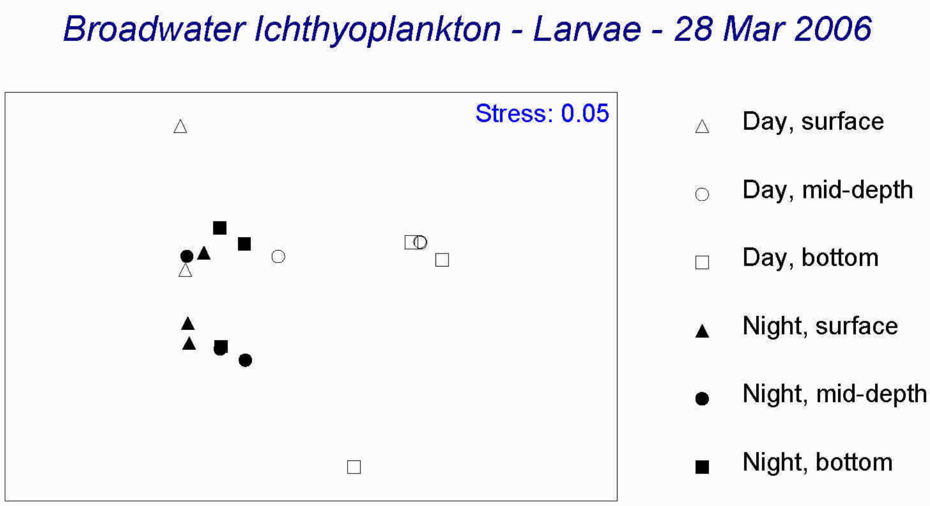


Figure 7. Non-metric multidimensional scaling ordination of 18 (3 replicate stations, 2 diel periods, 3 depth strata) samples collected on March 28, 2006 for 4th root transformed fish larvae density (#/100m^3) based on Bray-Curtis similarities.

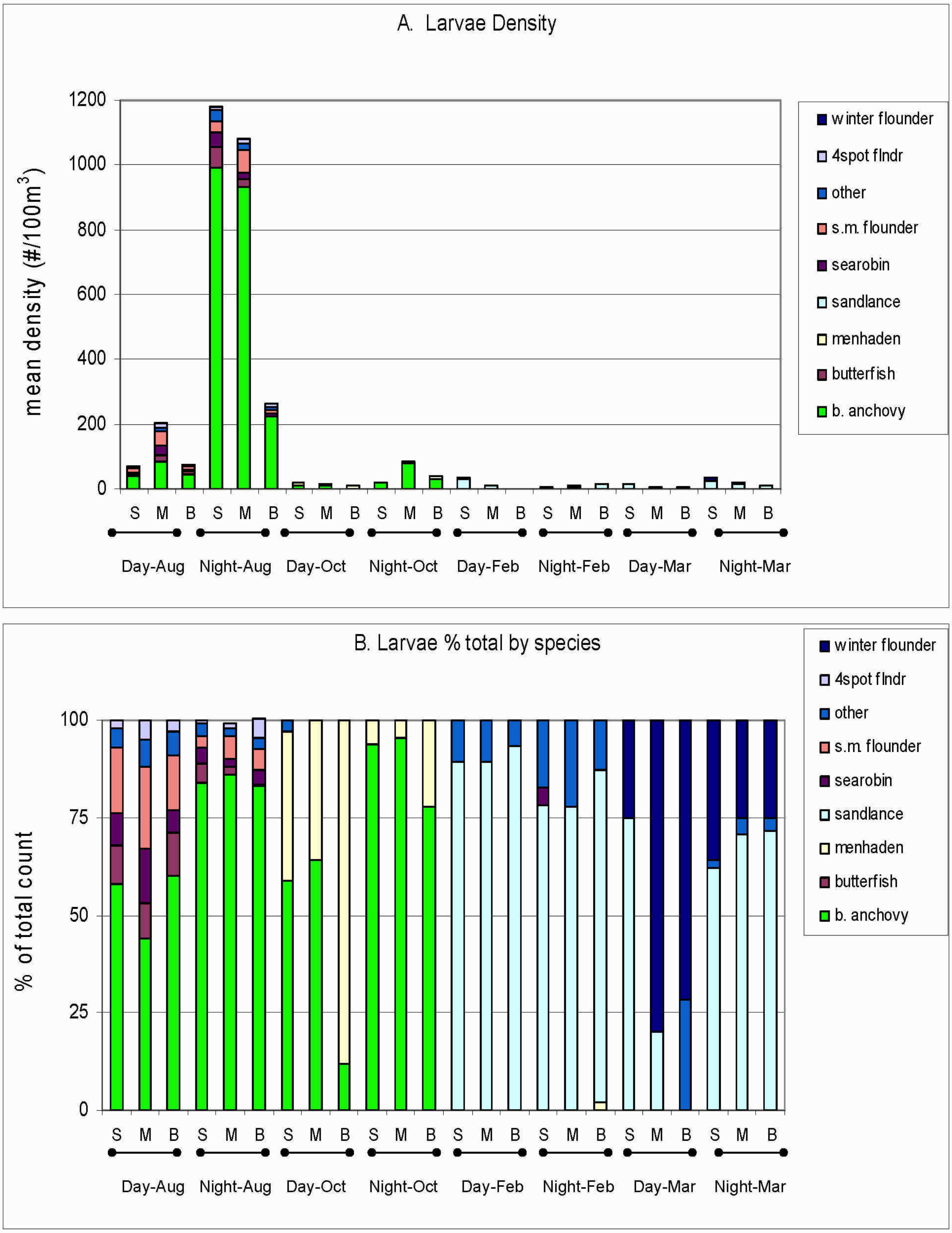


Figure 8. Fish larvae density (A) and species composition (B) in each diel/depth (S= surface, M= mid-depth, B= bottom) strata during site specific collections at the proposed FSRU facility on August 28, 2005, October 4, 2005, February 8, 2006, and March 28, 2006.

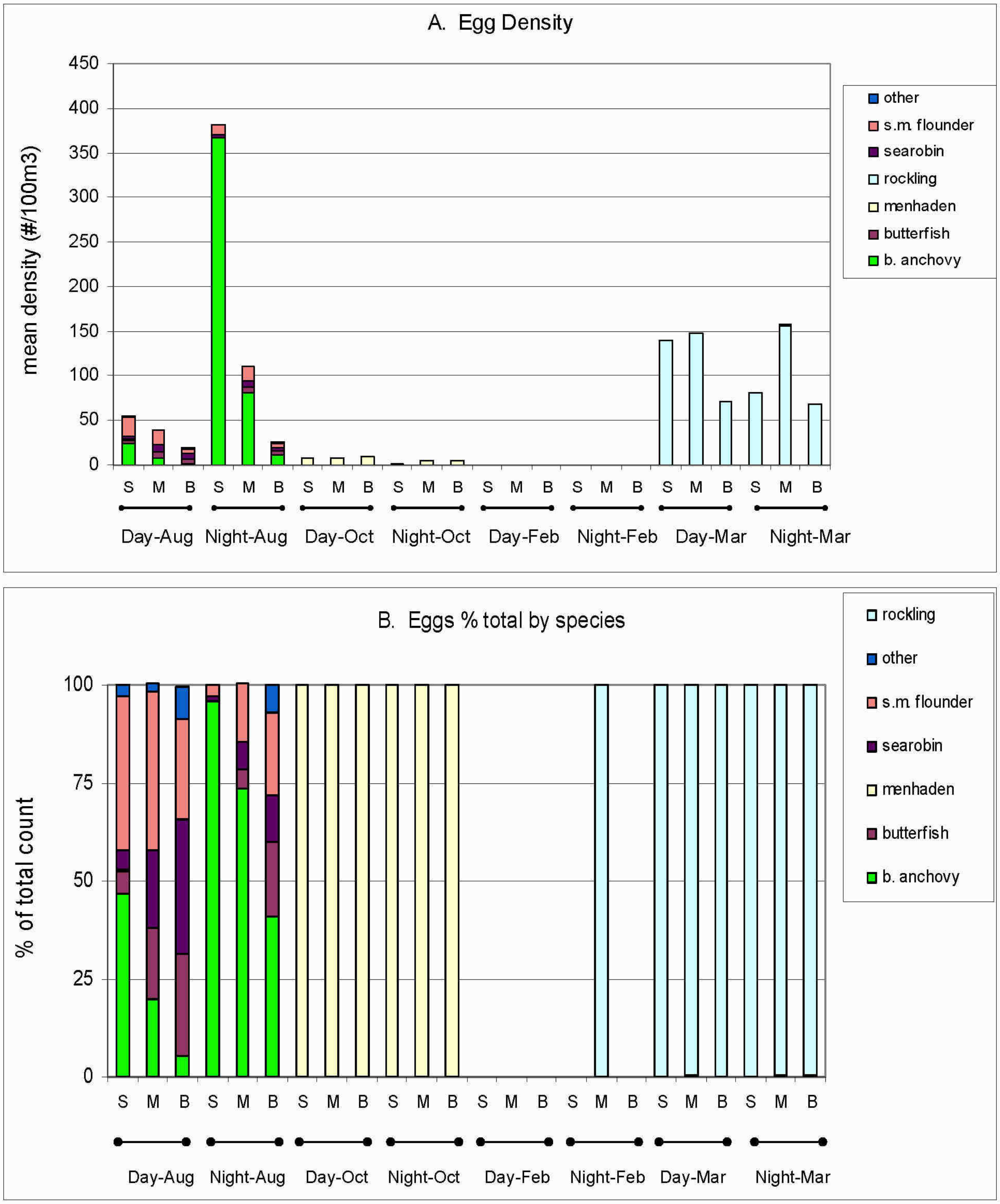


Figure 9. Fish egg density (A) and species composition (B) in each diel/depth (S= surface, M= mid- depth, B= bottom) strata during site specific collections at the proposed FSRU facility on August 28, 2005, October 4, 2005, February 8, 2006, and March 28, 2006.

Table 1. Sample allocation, sample depths and volume of water sampled (m^3) among the three random stations, three depth strata, and two diel periods sampled in the vicinity of the proposed Broadwater FSRU facility on March 28, 2006.

Station	Depth Strata	Sample Depth (ft.)	Diel Period	Volume Sampled
4	Surface	20	Day	254.9
	Mid-depth	49		302.0
	Bottom	87		296.2
	Surface	20	Night	305.9
	Mid-depth	48		285.3
	Bottom	86		319.3
5	Surface	20	Day	299.9
	Mid-depth	47		315.4
	Bottom	85		300.1
	Surface	20	Night	223.8
	Mid-depth	48		309.9
	Bottom	87		296.3
6	Surface	20	Day	273.0
	Mid-depth	46		281.6
	Bottom	81		283.7
	Surface	20	Night	311.4
	Mid-depth	49		290.1
	Bottom	91		311.1

Table 2. Temperature, dissolved oxygen, and salinity at the three stations during day and night sampling in the vicinity of the proposed Broadwater FSRU on March 28, 2006.

	Temperature (°C)				Dissolved Oxygen (mg/l)				Salinity ($^0/_{00}$)			
	min	max	mean	stdev.	min	max	mean	stdev.	min	max	mean	stdev.
Station 4												
Day	3.9	5.0	4.2	0.3	10.3	11.0	10.8	0.3	26.0	26.7	26.3	0.3
Night	3.8	5.4	4.3	0.5	10.9	11.1	11.0	0.1	25.5	26.2	25.8	0.2
Station 5												
Day	3.9	5.2	4.1	0.3	10.6	11.1	10.9	0.1	26.0	26.8	26.5	0.3
Night	3.8	4.7	4.1	0.3	10.8	11.1	10.9	0.1	25.6	26.7	26.0	0.4
Station 6												
Day	3.8	5.2	4.2	0.4	10.9	11.2	11.0	0.1	25.5	26.8	26.2	0.5
Night	3.7	4.7	4.2	0.3	10.6	11.1	10.9	0.2	25.6	26.5	25.8	0.3

Table 3. Number of fish eggs, larvae (yolk-sac + post yolk-sac stages) and young of the year (YOY) and the percent contribution to the total catch by species in the 18 ichthyoplankton tows conducted in the vicinity of the proposed Broadwater FSRU on March 28, 2006.

Common Name	Scientific Name	# Eggs	% Total Eggs	# YSL	# PYSL	# Larvae	% Total Larvae	# YOY	% Total YOY
Fourbeard rockling	*Enchelyopus cimbrius*	5860	99.76						
American sand lance	*Ammodytes americanus*				516	516	66.55		
Winter flounder	*Pseudopleuronectes americanus*			70	200	270	33.25		
Rock gunnel	*Pholis gunnellus*				22	22	2.71		
Windowpane	*Scophthalmus aquosus*	8	0.14						
Yellowtail flounder	*Limanda ferruginea*	6	0.10						
Grubby	*Myoxocephalus aenaeus*				4	4	0.49		
TOTAL		5874				812			

Table 4. **Mean egg density (#/100m³) and percent of the total catch for each species collected in the three replicate samples in each diel period and depth strata in the vicinity of the proposed Broadwater FSRU on March 28, 2006.**

	Day						Night					
	Depth Strata						Depth Strata					
	Surface		Mid-depth		Bottom		Surface		Mid-depth		Bottom	
Fish Eggs	# per 100m³	% Total	# per 100m³	% Total	# per 100m³	% Total	# per 100m³	% Total	# per 100m³	% Total	# per 100m³	% Total
Fourbeard rockling	140.09	100.00	147.63	99.71	71.35	100.00	81.94	100.00	155.97	99.43	67.48	99.69
Windowpane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.57	0.00	0.00
Yellowtail flounder	0.00	0.00	0.44	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.31
Total	140.09	100.00	148.08	100.00	71.35	100.00	81.94	100.00	156.87	100.00	67.69	100.00

Table 5. **Mean larvae (yolk sac + post yolk sac stage) density (#/100m³) and percent of the total catch for each species collected in the three replicate samples in each diel period and depth strata in the vicinity of the proposed Broadwater FSRU on March 28, 2006.**

	Day						Night					
	Depth Strata						Depth Strata					
	Surface		Mid-depth		Bottom		Surface		Mid-depth		Bottom	
Species	# per 100 m³	% Total	# per 100 m³	% Total	# per 100 m³	% Total	# per 100 m³	% Total	# per 100 m³	% Total	# per 100 m³	% Total
American sandlance	12.84	75.00	0.85	20.00			22.48	62.16	15.78	70.83	8.58	71.43
Grubby					0.47	14.29						
Rock gunnel					0.47	14.29	0.73	2.03	0.89	4.17	0.45	3.57
Winter flounder	4.40	25.00	3.52	80.00	2.25	71.43	12.39	35.81	5.50	25.00	3.07	25.00
Total	17.23	100.00	4.37	100.00	3.19	100.00	35.60	100.00	22.17	100.00	12.10	100.00

Table 6. Egg, yolk-sac larvae (YSL) and post yolk-sac larvae (PYSL) densities (#/100m^3) at the three randomly selected sampling stations and three depth strata during daytime sampling in the vicinity of the proposed Broadwater FSRU on March 28, 2006.

Daytime Survey		Station 4			Station 5			Station 6		
		Surface	Mid-depth	Bottom	Surface	Mid-depth	Bottom	Surface	Mid-depth	Bottom
American sandlance	PYSL				10.67	2.54		27.84		
Grubby	PYSL									1.41
Rock gunnel	PYSL									1.41
Winter flounder	YSL		1.32			5.07		1.47	1.42	1.41
	PYSL		1.32	1.35			4.00	11.72	1.42	
Fourbeard rockling	Egg	23.54	7.95	12.15	256.09	317.06	7.33	140.66	117.90	194.57
Yellowtail flounder	Egg		1.32							

Table 7. Egg, yolk-sac larvae (YSL), and post yolk-sac larvae (PYSL) densities (#/100m^3) at the three randomly selected sampling stations and three depth strata during nighttime sampling in the vicinity of the proposed Broadwater FSRU on March 28, 2006.

Nighttime Survey		Station 4			Station 5			Station 6		
		Surface	Mid-depth	Bottom	Surface	Mid-depth	Bottom	Surface	Mid-depth	Bottom
American sandlance	PYSL	17.00	39.26	11.27	28.60	2.58	6.75	21.84	5.52	7.71
Rock gunnel	PYSL	1.31			0.89	1.29	1.35		1.38	
Winter flounder	YSL	3.92	4.21	0.63		1.29	2.70			
	PYSL	17.00	2.80	0.63	9.83	1.29	2.70	6.42	6.89	2.57
Four bearded rockling	EGG	28.77	171.05	150.96	132.26	236.21	28.35	84.78	60.67	23.14
Windowpane	EGG		1.40			1.29				
Yellowtail flounder	EGG			0.63						

Table 8. **Species richness (# species identified to at least genus level in a sample), Shannon-Wiener diversity index (H'), and density (#/100m^3) of eggs and larvae (yolk-sac + post yolk-sac stage) at the three random sampling stations, three depth strata, and two diel periods sampled in the vicinity of the proposed Broadwater FSRU on March 28, 2006.**

Station	Depth Strata	Diel Period	Species Richness		Diversity (H')		Density (#/100m^3)	
			Eggs	Larvae	Eggs	Larvae	Eggs	Larvae
4	Surface	Day	1	0	0.00		23.54	0.00
	Mid-depth		2	1	0.41	0.00	9.27	2.65
	Bottom		1	1	0.00	0.00	12.15	1.35
	Surface	Night	1	3	0.00	0.81	28.77	39.23
	Mid-depth		2	2	0.05	0.43	172.45	46.27
	Bottom		2	2	0.03	0.33	151.58	12.53
5	Surface	Day	1	1	0.00	0.00	256.09	10.67
	Mid-depth		1	2	0.00	0.64	317.06	7.61
	Bottom		1	1	0.00	0.00	7.33	4.00
	Surface	Night	1	3	0.00	0.66	132.26	39.32
	Mid-depth		2	3	0.03	1.05	237.50	6.45
	Bottom		1	3	0.00	0.94	28.35	13.50
6	Surface	Day	1	2	0.00	0.63	140.66	41.03
	Mid-depth		1	1	0.00	0.00	117.9	2.84
	Bottom		1	3	0.00	1.09	194.57	4.23
	Surface	Night	1	2	0.00	0.54	84.78	28.26
	Mid-depth		1	3	0.00	0.94	60.67	13.79
	Bottom		0	2	0.00	0.56	23.14	10.29

Table 9. Average density (#/100m^3) of fish larvae (± standard deviation) collected during day (n=3) and night (n=3) tows from the mid-depth strata in the vicinity of the proposed Broadwater FSRU on March 28, 2006. Daily entrainment estimates were determined by multiplying the average density by the average daily withdrawal by the FSRU and associated LNG carriers (28.2 MGD, 106,750 m^3/day).

Species	Stage	Average Density (#/100m^3) ± stdev	Daily Entrainment Estimate	95 % Confidence Intervals
American sand lance	PYSL	8.32 ± 15.30	8,878	0-21,944
fourbeard rockling	Egg	151.81 ± 113.98	162,054	64,699-259,408
rock gunnel	PYSL	0.45 ± 0.69	475	0-1,064
windowpane	Egg	0.45 ± 0.70	479	0-1,073
winter flounder	YSL	2.22 ± 1.97	2,368	689-4,047
	PYSL	2.29 ± 2.42	2,441	371-4,511
yellowtail flounder	Egg	0.22 ± 0.54	235	0-695

Table 10. Lifestage specific mortality rates used by EPA (2004) to calculate daily Age-1 equivalent estimates lost to entrainment in the FSRU facility. Instantaneous Total Mortality (Z) is the sum of Natural Mortality (M) and Fishing Mortality (F), (Z=M+F). Survival rate (S) is the estimated proportion of a lifestage that survives from the beginning to the end of that stage ($S= e^{-z}$). An adjusted survival rate (S*) was applied to the stage at which entrainment occurs as explained in the text.

								Estimated number entrained/day that would survive			
Species	Stage Name	M[a]	F[a]	Z	S	S*	# Entrained/Day	Egg to Later Stages	Larvae to Later Stages	Juvenile to Later Stages	Estimated total # Age 1 Entrained
American sandlance	Larvae	2.97	0	2.97	0.05	0.10	8,879		888		
	Juvenile	2.90	0	2.90	0.06		0		49		49
[a] From Table C1-3 in EPA (2004)											
Fourbeard rockling	Eggs	2.30	0	2.30	0.10	0.18	162,054	29,170			
	Larvae	4.25	0	4.25	0.01		0	416			
	Juvenile	0.92	0	0.92	0.40		0	166			166
[a] From Table C1-17 in EPA (2004)											
Rock gunnel	Larvae	1.66	0	1.66	0.19	0.32	475		152		
	Juvenile	0.92	0	0.92	0.40		0		61		61
[a] From Table C1-26 in EPA (2004)											
Winter flounder	Larvae	4.37	0	4.37	0.01	0.03	4,809		120		
	Juvenile	2.38	0	2.38	0.09				11		11
[a] From Table D1-29 in EPA (2004)											
Windowpane	Eggs	1.41	0	1.41	0.24	0.39	479	188			
	Larvae	6.99	0	6.99	0.001		0	0.2			
	Juvenile	2.98	0	2.98	0.05		0	0			0
[a] From Table D1-28 in EPA (2004)											
Yellowtail flounder	Eggs	0.29	0	0.29	0.75	0.86	235	201			
	Larvae	9.17	0	9.17	0.0001		0	0			
	Juvenile	2.38	0	2.38	0.09		0	0			0

[a] From Table C1-42 in EPA (2004)

Table 11. **Summary of daily entrainment estimates collected in the vicinity of the proposed Broadwater FSRU on four sampling dates (August 23, 2005, October 4, 2005, February 8, 2006, and March 28, 2006). Entrainment estimates were generated by multiplying average ichthyoplankton density from the six replicate tows (3 day, 3 night) in the mid-depth strata (35-65 feet) by the average daily withdrawal by the FSRU facility (106,750m^3).**

Species	Stage	Daily Entrainment Estimates			
		23-Aug-05	4-Oct-05	8-Feb-06	28-Mar-06
American sand lance	PYSL			8,444	8,878
Atlantic mackerel	YSL	356			
	PYSL	4,092			
Atlantic menhaden	Egg		6,245		
	PYSL		5,071		
Bay Anchovy	Egg	47,860			
	YSL	356			
	PYSL	543,358	47,557		
	YOY		1,245		
Black sea bass	PYSL	3,736			
Butterfish	Egg	6,583			
	PYSL	23,485			
Cunner	PYSL	2,135			
Fourbeard rockling	Egg			109	162,054
Fourspot flounder	PYSL	13,344			
Grubby	PYSL			59	
Longhorn sculpin	PYSL			109	
Northern Puffer	PYSL	356			
Rock gunnel	PYSL			1,471	475
Searobin	Egg	7,650			
	YSL	178			
	PYSL	25,264			
Smallmouth Flounder	Egg	17,080			
	YSL	7,117			
	PYSL	53,019			
Striped Cuskeel	PYSL	4,092			
Unidentified	Egg	356			
	YSL	356			
Weakfish	PYSL	890			
Windowpane	Egg				479
	PYSL	356			
Winter flounder	YSL				2,368
	PYSL				2,441
Yellowtail flounder	Egg				235
SUM	**Eggs**	**79,529**	**6,245**	**109**	**162,768**
	YSL	**8,363**	**0**	**0**	**2,368**
	PYSL	**674,127**	**52,628**	**10,083**	**11,794**

Table 12. Entrainment estimates for the August 1, 2005-March 31, 2006 period derived from samples collected in the vicinity of the proposed Broadwater FSRU on four sampling dates (August 23, 2005, October 4, 2005, February 8, 2006, and March 28, 2006). Daily entrainment estimates (Table 11) were extrapolated to represent the August-March period. The August 23 sample was considered representative of August 1-Sept 15 (46 days), the October 4 sample represents September 16-November 30 (76 days), the February 8 sample represents December 1-February 28 (90 days), and the March 28 sample represents March 1-31 (31 days). Data is presented as Day and Night samples combined, and for Night samples only for larval fish.

		Estimated number entrained- Day and night samples					Estimated number entrained- Night samples Only (YSL, PYSL only)				
Species	Stage	1-Aug-15 Sep	16 Sep-30 Nov	1 Dec 05-28 Feb	1 Mar -31 Mar	SUM	1-Aug-15 Sep	16 Sep-30 Nov	1 Dec 05-28 Feb	1 Mar -31 Mar	SUM
American sand lance	PYSL	0	0	759,960	275,218	1,035,178	0	0	680,850	522,412	1,203,262
Atlantic mackerel	YSL	16,376	0	0	0	16,376	32,738	0	0	0	32,738
	PYSL	188,232	0	0	0	188,232	376,473	0	0	0	376,473
Atlantic menhaden	Egg	0	474,620	0	0	474,620	0	474,620	0	0	474,620
	PYSL	0	385,396	0	0	385,396	0	324,520	0	0	324,520
Bay Anchovy	Egg	2,201,560	0	0	0	2,201,560	2,201,560	0	0	0	2,201,560
	YSL	16,376	0	0	0	16,376	32,738	0	0	0	32,738
	PYSL	24,994,468	3,614,332	0	0	28,608,800	45,798,598	6,409,308	0	0	52,207,906
	YOY	0	94,620	0	0	94,620	0	189,316	0	0	189,316
Black sea bass	PYSL	171,856	0	0	0	171,856	65,472	0	0	0	65,472
Butterfish	Egg	302,818	0	0	0	302,818	302,818	0	0	0	302,818
	PYSL	1,080,310	0	0	0	1,080,310	1,227,625	0	0	0	1,227,625
Cunner	PYSL	98,210	0	0	0	98,210	147,315	0	0	0	147,315
Fourbeard rockling	Egg	0	0	9,810	5,023,674	5,033,484	0	0	9,810	5,023,674	5,033,484
Fourspot flounder	PYSL	613,824	0	0	0	613,824	720,208	0	0	0	720,208
Grubby	PYSL	0	0	5,310	0	5,310	0	0	10,530	0	10,530
Longhorn sculpin	PYSL	0	0	9,810	0	9,810	0	0	19,530	0	19,530
Northern Puffer	PYSL	16,376	0	0	0	16,376	0	0	0	0	0
Rock gunnel	PYSL	0	0	132,390	14,725	147,115	0	0	163,980	29,450	193,430
Searobin	Egg	351,900	0	0	0	351,900	351,900	0	0	0	351,900
	YSL	8,188	0	0	0	8,188	0	0	0	0	0
	PYSL	1,162,144	0	0	0	1,162,144	965,733	0	0	0	965,733
Smallmouth flounder	Egg	785,680	0	0	0	785,680	785,680	0	0	0	785,680
	YSL	327,382	0	0	0	327,382	540,155	0	0	0	540,155
	PYSL	2,438,874	0	0	0	2,438,874	2,848,090	0	0	0	2,848,090
Striped Cuskeel	PYSL	188,232	0	0	0	188,232	212,787	0	0	0	212,787
Unidentified	Egg	16,376	0	0	0	16,376	16,376	0	0	0	16,376
	YSL	16,376	0	0	0	16,376	0	0	0	0	0
Weakfish	PYSL	40,940	0	0	0	40,940	0	0	0	0	0
Windowpane	Egg	0	0	0	14,849	14,849	0	0	0	14,849	14,849
	PYSL	16,376	0	0	0	16,376	0	0	0	0	0
Winter flounder	YSL	0	0	0	73,408	73,408	0	0	0	60,667	60,667
	PYSL	0	0	0	75,671	75,671	0	0	0	121,117	121,117
Yellowtail flounder	Egg	0	0	0	7,285	7,285	0	0	0	7,285	7,285
SUM	**Eggs**	**3,658,334**	**474,620**	**9810**	**5,045,808**	**9,188,572**	**3,658,334**	**474,620**	**9,810**	**5,045,808**	**9,188,572**
	YSL	**384,698**	**0**	**0**	**73,408**	**458,106**	**605,631**	**0**	**0**	**60,667**	**666,298**
	PYSL	**31,009,842**	**3,999,728**	**907,470**	**365,614**	**36,282,654**	**52,362,301**	**6,733,828**	**874,890**	**672,979**	**60,643,998**

Table 13. **Ichthyoplankton entrainment estimates by species for the Poletti Program (Mar. 4-Aug. 5, 2002) in the Intermediate (6-30m) and Deep (> 30m) depth strata under two different diel scenarios[a] and the site specific collections at the FSRU location (August 1, 2005-March 31, 2006) under two diel scenarios[b].**

	2002 Poletti								2006 Broadwater Site Specific		
	Egg Estimate				Larvae Estimate				Egg Estimate	Larvae Estimate	
	Intermediate Depth Strata		Deep Depth Strata		Intermediate Depth Strata		Deep Depth Strata				
	Entrainment Scenario		Entrainment Scenario		Entrainment Scenario		Entrainment Scenario		Diel Period		
Species	1	2	1	2	1	2	1	2	Day & Night	Day & Night	Night Only
American lobster	0	0	0	0	47,525	47,525	43,490	43,490	0	0	0
American sandlance	0	0	0	0	553,413	553,413	391,260	391,260	0	1,035,178	1,203,262
Atlantic herring	0	0	0	0	299	299	0	0	0	0	0
Atlantic mackerel	52,158	52,158	22,716	22,716	70,540	70,540	86,083	86,083	0	204608	409,211
Atlantic menhaden	22,836,558	22,836,558	1,615,405	1,615,405	31,897,263	31,897,263	13,820,987	13,820,987	474,620	385,396	324,520
Atlantic silverside	0	0	0	0	0	0	4,633	4,633	0	0	0
Bay anchovy	2,748,087	18,137,372	582,556	3,844,870	1,423,810	18,367,151	907,460	11,706,239	2,201,560	28,625,176	52,240,644
Black seabass	0	0	0	0	73,081	73,081	4,334	4,334	0	171,856	65,472
Butterfish	554,011	554,011	149,151	149,151	4,056,521	4,056,521	222,979	222,979	302,818	1,080,310	1,227,625
Cod (Family)	31,086	31,086	0	0	448	448	0	0	0	0	0
Cunner	3,254,423	3,254,423	2,041,636	2,041,636	10,895,054	10,895,054	2,735,533	2,735,533	0	98,210	147,315
Feather blenny	0	0	0	0	1,345	1,345	8,070	8,070	0	0	0
Fourbeard rockling	20,224,022	20,224,022	21,961,080	21,961,080	6,260,610	6,260,610	1,511,537	1,511,537	5,033,484	0	0
Fourspot flounder	0	0	0	0	542,055	1,246,727	134,206	308,674	0	613,824	720,208
Gobiidae	0	0	0	0	263,181	263,181	172,615	172,615	0	0	0
Grubby	0	0	0	0	55,147	55,147	42,892	42,892	0	5,310	10,530
Herrings	0	0	0	0	0	0	23,015	23,015	0	0	0
Hogchoker	40,501	40,501	37,213	37,213	3,138	3,138	0	0	0	0	0
Longhorn sculpin	0	0	0	0	0	0	0	0	0	9,810	19,530
Northern pipefish	0	0	0	0	4,334	4,334	8,967	8,967	0	0	0
Northern puffer	0	0	0	0	0	0	0	0	0	16,376	0
Rock gunnel	0	0	0	0	299	299	2,242	2,242	0	147,115	193,430
Scup	9,490,761	9,490,761	1,963,833	1,963,833	21,004,450	21,004,450	2,212,906	2,212,906	0	0	0
Searobin	8,488,162	8,488,162	3,722,650	3,722,650	1,974,235	1,974,235	1,037,034	1,037,034	351,900	1,170,332	965,733
Smallmouth flounder	0	0	0	0	1,196	1,196	3,138	3,138	785,680	2,766,256	3,388,245
Striped anchovy	72,782	72,782	0	0	0	0	0	0	0	0	0
Striped cusk-eel	0	0	0	0	0	0	1,196	1,196	0	188,232	212,787
Tautog	7,088,712	7,088,712	5,922,106	5,922,106	11,554,727	11,554,727	3,911,704	3,911,704	0	0	0
Unidentified	26,453	26,453	0	0	194,883	194,883	12,703	12,703	16,376	16,376	0
Weakfish	361,581	361,581	1,057,448	1,057,448	770,863	770,863	1,086,651	1,086,651	0	40,940	0
Windowpane	2,020,564	2,020,564	1,553,234	1,553,234	1,498,984	1,498,984	852,612	852,612	14,849	16,376	0
Winter flounder	897	897	5,081	5,081	964,999	964,999	1,404,979	1,404,979	0	149,079	181,784
Yellowtail flounder	0	0	1,644	1,644	0	0	0	0	7,285	0	0
Sum (Mar 4-Aug 5, 2002)	**77,290,758**	**92,680,043**	**40,635,753**	**43,898,067**	**94,112,401**	**111,760,413**	**30,643,226**	**41,616,473**			
Sum (Aug 1-Mar 31, 2006)									**9,188,572**	**36,740,760**	**61,310,296**

[a] Scenario 1 is based on unadjusted daytime tows: Scenario 2- bay anchovy eggs and fourspot flounder have been adjusted as described in Normandeau (2006, Appendix A)
[b] Estimates are (1) based on the mean of three replicate daytime and three nighttime tows from the mid-depth strata, and (2) based on nighttime collections only for larvae.

Table 14. Ichthyoplankton entrainment estimates (millions) summed over all eleven biweekly surveys of the 2002 Poletti Ichthyoplankton Program and for the site specific collections in 2005-06 at the proposed Broadwater FSRU location.

					Entrainment Estimate (millions)	
Program	**Dates Included**	**Depth sampled**	**Total Depth at Sample Location**	**Diel**	**Eggs**	**Larvae**
Poletti	March 4-Aug. 5, 2002	surface to 10 ft above bottom[d]	Deep (total depth > 98 ft)	day only	40.6	30.6
Poletti	March 4-Aug. 5, 2002	surface to 10 ft above bottom	Deep (total depth > 98 ft)	day- adjusted[a]	43.9	41.6
Poletti	March 4-Aug. 5, 2002	surface to 10 ft above bottom	Intermediate (total depth 20-98 ft)	day only	77.3	94.1
Poletti	March 4-Aug. 5, 2002	surface to 10 ft above bottom	Intermediate (total depth 20-98 ft)	day- adjusted[a]	92.7	111.8
Broadwater	Aug 1, 2005-March 31, 2006	mid-depth (35-65 ft)	~ 95 ft	day and night[b]	9.2	36.7
Broadwater	Aug 1, 2005-March 31, 2006	mid-depth (35-65 ft)	~ 95 ft	day and night[c] (eggs), night only (larvae)	9.2	61.3

[a] Poletti samples were only conducted during the day. A diel adjustment factor was applied based on analysis in Appendix A of Normandeau (2006).

[b] Broadwater samples are the average of three day and three night samples

[c] Broadwater samples are the average of (1) day and night for eggs, and (2) night only for larvae to adjust for possible gear avoidance.

[d] Poletti samples were collected from randomly selected depths within the water column and mixed into a composite sample in the laboratory within a given gear/biweekly survey/region stratum as discussed in Normandeau 2006

Table 15. Comparison of mean ichthyoplankton density from Poletti Program Survey # 2 (March 18-31, 2002) from the central basin region of Long Island Sound in the Deep (total water depth > 98 ft) and Intermediate (total water depth 6-98 ft) depth strata and the March 28, 2006 site specific collections (daytime, mean of three replicate tows in each of the three depth strata (n=9) ± stdev.). Poletti tows were collected during the daytime and sample variance is not available because all samples within a given gear/survey/depth strata were combined in the laboratory to form a composite sample (see Normandeau 2006 for details).

Species	Stage	Density (#/100m^3)		
		Poletti-Deep	Poletti-Intermediate	Broadwater
Fourbeard rockling	eggs	306.1	171.0	119.7 (± 42.0)
	larvae		0.1	
American sandlance	larvae	13.9	6.2	4.6 (± 7.2)
Atlantic menhaden	larvae		0.1	
Grubby	larvae	0.9	1.0	0.2 (± 0.3)
Rock gunnel	larvae	0.1		0.2 (± 0.3)
Windowpane	eggs	0.9		
Winter flounder	larvae	50.7	7.4	3.4 (± 1.1)
Yellowtail flounder	eggs			0.1 (± 0.3)

EIR2-9

Request:

Provide Broadwater's response to the NYSDEC letter dated March 9, 2006 regarding the applicability of federal PSD review for the proposed Project.

Response:

The response is attached.

LeBoeuf, Lamb, Greene & MacRae LLP

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May 3, 2006

BY ELECTRONIC AND FIRST CLASS MAIL

Steven C. Riva, Chief
Permitting Section
Air Programs Branch
U.S. Environmental Protection Agency, Region 2
290 Broadway
New York, NY 10007-1866

Re: Broadwater Energy Project – Responses to EPA's March 9, 2006 Letter

Dear Mr. Riva:

Attached hereto are the responses of Broadwater Energy LLC and Broadwater Pipelines LLC ("Broadwater Energy") to the U.S. Environmental Protection Agency's March 9, 2006 letter providing comments on Resource Report No. 9 (addressing air and noise quality) for the Broadwater Energy Project.

Please do not hesitate to contact me or Sandra Barnett at 403-920-7776 if you have any questions concerning the attached responses.

Respectfully submitted,

James A. Thompson

James A. Thompson, Jr.
Counsel for Broadwater Energy

Attachments

cc: Sandra Barnett (Broadwater Energy)
Kristine Delkus (Broadwater Energy)
Robert J. Alessi (LLGM)

BROADWATER

1. **The various Standard Industrial Classification (SIC) Codes that will be applicable for the proposed facility (floating storage and regasification unit [FSRU] and vessels) and for each group of polluting emitting equipment that has a specific function should be listed in the report.**

RESPONSE

The following response identifies the primary SIC codes applicable to the FSRU, the liquefied natural gas carriers ("LNGCs"), and each group of pollutant emitting equipment that has a specific function on the FSRU and the LNGCs:

Equipment	SIC Code	Explanation	PSD Threshold
FSRU	4922 (Natural Gas Transmission)	The primary purpose of the FSRU is to store and regasify LNG and deliver natural gas	250 TPY
Process Heaters (Four with one backup)	4922 (Natural Gas Transmission)	Processing equipment on the FSRU	250 TPY/100 TPY (Fossil fuel boilers > 250 MMBTU/hr)
Turbines (Two with one backup)	4922 (Natural Gas Transmission)	Power generation equipment on the FSRU	250 TPY/100 TPY (Fossil fuel steam electric plants > 250 MMBTU/hr)
Emergency Diesel Generators (Three)	4922 (Natural Gas Transmission)	Power generation equipment on the FSRU	250 TPY
Diesel Firewater Pumps (Two)	4922 (Natural Gas Transmission)	Safety equipment on the FSRU	250 TPY
LNGCs	4412 (Deep Sea Foreign Transportation of Freight)	The primary purpose of the LNGCs is to transport and deliver LNG	N/A
Boilers (for certain LNGCs)	4412 (Deep Sea Foreign Transportation of Freight)	Propulsion and power generation equipment on the LNGCs	N/A[1]
Diesel Engines (for certain LNGCs)	4412 (Deep Sea Foreign Transportation of Freight)	Propulsion and power generation equipment on the LNGCs	N/A[2]

[1] If assumed to be part of the "stationary source" then 250 TPY/100 TPY (Fossil Fuel Boilers > 250 MMBTU/hr).
[2] If assumed to be part of the "stationary source" then 250 TPY.

2. Consistent with the guidance provided in the October 28, 2003 EPA letter from Charles J. Sheehan, Regional Counsel, EPA Region 6 to Mr. Michael Cathey and Ms. Diana Dutton, from El Paso Energy Bridge Gulf of Mexico, L.L.C. and Akin, Gump, Strauss, Hauer & Feld, L.L.P., respectively, EPA Region 2, in coordination with our OAQPS office, has determined that certain emissions from the vessels should be counted toward the PTE (potential to emit) of the FSRU. More specifically, for PSD applicability purposes, the vessel emissions related to off-loading and on-board processing of the LNG count towards the PTE of the FSRU and that emissions related to hotelling and propulsion of the vessel do not count towards the PTE of the FSRU.

Consequently, the report should contain a detailed breakdown of emissions (with a detailed discussion) quantifying vessel emissions that correspond to the off-loading and on-board processing of the LNG and quantifying vessel emissions that correspond to hotelling and other ship functions while at berth. If there are more than one unit (boiler/diesel engine) producing these emissions, specify these units. The report should also break down the emissions on a unit by unit basis so it is clear which units on the ships are generating the emissions for these various functions. PTE emissions from the FSRU should be recalculated by incorporating the corresponding emissions from the vessels not associated with hotelling.

RESPONSE

Broadwater Energy LLC and Broadwater Pipelines LLC (collectively "Broadwater Energy") have reviewed the October 23, 2003 letter referenced in EPA Region 2's March 9, 2006 letter and respectfully requests that EPA Region 2 reconsider its preliminary determination in light of the discussion provided below. Please note that while Broadwater Energy disagrees with the Region's preliminary determination, to develop a productive dialogue between the parties and facilitate a prompt resolution of this issue, Broadwater Energy has quantified LNGC emissions attributable to the offloading of LNG to the FSRU. These emission calculations demonstrate that the potential to emit ("PTE") of the Project, when including the category of LNGC emissions requested in the Region's March 9th letter, are below "major source" PSD thresholds.

A. Regulatory Framework

Broadwater Energy has evaluated the applicability of EPA's regulations and guidance concerning "stationary sources" in light of the specific configuration of the Broadwater Project ("Project") and the business relationship between Broadwater Energy (the owner/operator of the FSRU) and the owners/operators of the LNGCs that are expected to deliver LNG to the FSRU. Based upon this evaluation, Broadwater Energy does not believe that the LNGCs, when connected to the FSRU, are part of the "stationary source" subject to PSD permitting. For the sole purpose of this analysis, and in accord within the position taken by EPA in its letter to El Paso Energy Bridge, Broadwater Energy has assumed that neither EPA's 1980 "control and proximity" regulations nor its 1982 rulemaking that exempted all vessel emissions (to the extent vacated in Natural Resources Defense Council v. EPA, 725 F.2d 761, 771 (D.C. Cir. 1984)) will influence the outcome of EPA's determination on this issue. Rather, the definitions in the Clean Air Act and EPA's implementing regulations are assumed to control.

In accordance with EPA's Draft New Source Review Workshop Manual (October 1990) and 40 C.F.R. § 52.21, the threshold requirement to determine whether PSD applies to the Project is to define the "stationary source." A "stationary source" is "any building, structure, facility, or installation which emits or may emit a regulated NSR pollutant." 40 C.F.R. § 52.21(b)(5). "Building, structure, facility, or installation" means all pollutant-emitting activities which:

(1) Belong to the same "Major Group" (i.e., have the same first two digit code) as described in the SIC Manual;

(2) Are located on one or more contiguous or adjacent properties; and

(3) Are under the control of the same person (or persons under common control).

40 C.F.R. § 52.21(b)(6). Under EPA guidance, "support facilities" are "to be considered to be part of the same industrial grouping as that of the primary facility it supports even if the support facility has a different two digit SIC code." See Letter from Robert B. Miller, EPA Region 5 to William Baumann, Wisconsin Department of Natural Resources regarding Oscar Mayer Foods (August 25, 1999) ("Miller Letter"); see also Memorandum from John S. Seitz regarding Major Source Determinations for Military Installations under the Aix Toxics, New Source Review, and Title V Operating Permits Programs of the Clean Air Act (August 2, 1996) ("Seitz Memo").

A. The FSRU and the LNGCs Will Not Be Under Common Ownership or Control

Unlike the El Paso Energy Bridge Project and some other LNG projects under development, the Project will not have a dedicated fleet of LNGCs. In addition, due to the special nature of the El Paso Energy Bridge Project, the LNGCs servicing that project are equipped with regasification capabilities and become the processing and send out facility during discharge operations when stationary at the El Paso Energy Bridge Project.[3]

EPA's determination concerning *common ownership or control* "focuses on who has the power to manage the pollutant-emitting activities of the facilities at issue, including the power to make or veto decisions to implement major emission control measures or to influence production levels and compliance with environmental regulations. See Miller Letter, at 2 citing Seitz Memo.

[3] For the avoidance of doubt, it is important to note that the LNGCs that will service the Broadwater Project will not have onboard regasification capabilities (as is the case for the El Paso Energy Bridge Project and the Neptune Project or Northeast Gateway Project proposed in Boston Harbor). The equipment located on the Broadwater FSRU (i.e., the shell and tube vaporizers) will be used to regasify the LNG.

Broadwater Energy is a joint venture between TCPL USA LNG, Inc. and Shell Broadwater Holdings, LLC. Broadwater Energy will be the owner/operator of the FSRU. Broadwater Energy will not, however, own the delivered LNG nor own/operate the LNGCs which will deliver the LNG to the FSRU for processing. The LNG delivered to, stored at, and regasified by the FSRU is owned by Shell North America LNG ("SNALNG"). Broadwater Energy does not direct nor exercise management control over the actions of SNALNG.

SNALNG will purchase LNG from other Shell affiliates or third party suppliers. It is unlikely to have any influence over the actual vessels which are used to deliver cargoes to the Broadwater FSRU. In addition, it would be SNALNG (not Broadwater Energy) that potentially could have the ability to dictate the terms of delivery through negotiations. Broadwater Energy will retain the right to reject an LNGC nominated for delivery to the FSRU based on limited criteria, including any physical limitations of the FSRU to accommodate the delivery or the failure of the LNGC to be in compliance with international and domestic requirements/industry standards, safety/security measures adopted by Broadwater Energy, and United States Coast Guard administered laws and regulations.

Broadwater Energy will not own or operate the LNGCs nor will it have the ability to make operational decisions aboard the LNGCs. It is an established maritime practice that operational decisions concerning vessels always remain with the vessel owner/operator. This is true even when vessels are docked at port (and in this instance when the LNGC is docked alongside the FSRU and transferring LNG). Broadwater Energy cannot control nor can it ensure by contract the management of "polluting-emitting activities" on the LNGCs, let alone make or undo decisions made with respect to the implementation of emission control measures or compliance with environmental regulations by the separate companies owning/operating the LNGCs.

The Project is in certain ways analogous to the facts in the Miller Letter in which EPA Region 5 concluded that six power generators that were to be constructed on property owned by Oscar Mayer that would be used to provide backup power for Oscar Mayer's operations (but would be wholly owned by Madison Gas and Electric) were not part of the Oscar Mayer "stationary source" because the six generators at issue were not under "common control." In reaching this conclusion, EPA Region 5 noted that Oscar Mayer had no ownership interest in the generators and that the contract between the parties did not allow Oscar Mayer to control or make decisions regarding the "pollutant-emitting activities" associated with the generators.

Based upon the foregoing, Broadwater Energy respectfully submits that its Project and the LNGCs are not under "common ownership or control" as this phrase has been interpreted in EPA guidance. As a result, the LNGCs are not part of the "stationary source" for the purposes of PSD permitting and should be excluded from further evaluation with respect to this program.

B. The Boilers/Diesel Engines on the LNGCs Are Not Support Facilities to the FSRU and Are Not Part of the Same SIC Major Group

As noted in Broadwater Energy's response to Question #1, the FSRU (and related equipment) is part of SIC Major Group 49 and the LNGCs (and related equipment) are part of SIC Major Group 44. Broadwater Energy respectfully submits that neither the LNGCs nor the boilers/diesel engines on the LNGCs used to transfer LNG to the FSRU are "support facilities" as that term has been interpreted in EPA guidance. Therefore, the LNGCs and the boilers/diesel engines are not within the same SIC Major Group as the FSRU and are not part of the "stationary source" for the purpose of determining the applicability of PSD requirements.

The factors which must be considered by EPA in making its determination of whether the LNGCs or boilers/diesel engines on the LNGCs are "support facilities" for the FSRU were articulated in the Miller Letter:

> In short, where more than 50% of the output or services provided by one facility is dedicated to another facility that it supports then a support facility relationship is presumed to exist. Even where this 50% test is not met, however, other factors may lead the permitting authority to make a support facility determination. Support facility determinations can depend upon a number of financial, functional, contractual, and/or other legal factors. These include, but are not limited to: (1) the degree to which the supporting activity receives materials or services from the primary activity (which indicates a mutually beneficial arrangement between the primary and secondary activities); (2) the degree to which the primary activity exerts control over the support activity's operations; (3) the nature of any contractual arrangements between the facilities; and (4) the reasons for the presence of the support activity on the same site as the primary activity (e.g., whether the support activity would exist at the site but for the primary activity). Where these criteria indicate a support relationship, permitting authorities may conclude that a support activity contributing more or less than 50% of its output may be classified as a support facility and aggregated with the facility it supports as part of a single source.

When the LNGCs and the boilers/diesel engines on the LNGCs are viewed in light of this guidance, it is clear that a support facility relationship between the boilers/diesel engines on the LNGCs and the FSRU does not exist. The output of the boilers/diesel engines on the LNGCs only will be dedicated to the FSRU when the LNGCs are berthed at the FSRU and are transferring LNG; the output needed from the boilers/diesel engines to transfer the LNG is only a small portion of the total output capability of this equipment. In all other circumstances (e.g., transit, hoteling, etc.) the output of this equipment is dedicated to the LNGCs. In addition, the LNGCs that might service the Project will not be dedicated to the Project and only a limited amount of their overall operation/service time will be devoted to offloading cargo to the FSRU.

The other "financial, functional, contractual and/or other legal" factors that EPA relies on in determining whether a support facility relationship exists also are not present in the context of the Project. As noted, Broadwater Energy, the owner and operator of the FSRU, will have *no* control over the operation of the LNGCs or the boilers/diesel engines on the LNGCs (including "polluting-emitting activities" and decisions made with respect to implementation of emission control measures or compliance with environmental regulations); this control will be exclusive to the vessel owner/operator. Furthermore, since a third party will arrange and contract for the delivery of LNG to the FSRU, Broadwater Energy will not have a contractual relationship with the vessel owners/operators that would allow it to assert "control" over the vessels or the boilers/diesel engines on the vessels.

Finally, the primary reason that the boilers/diesel engines are in close proximity to the FSRU is because they are used to provide propulsion to the LNGCs. While it is true that the LNGCs would not be present at the FSRU "but for" the existence of the FSRU, the primary facility supported by the boilers/diesel engines is the LNGCs and not the FSRU. Similarly, as noted, the Project will not be the primary facility supported by the LNGCs which can service any LNG terminal. Even if the FSRU is assumed to be the "primary" facility supported by the LNGCs or the boilers/diesel engines (and therefore would not be present at the FSRU "but for" the existence of the FSRU), this factor alone does not conclusively establish that the vessel or this equipment is a "support facility." Rather, in evaluating all of the relevant factors noted in the Miller Letter and the Seitz Memo, it is clear that EPA's guidance would not treat an LNGC or the boilers/diesel engines aboard an LNGC as a "support facility" of the Project.

Based upon the foregoing: (1) the FSRU and LNGCs will not be under "common ownership or control"; and (2) the LNGCs and the boilers/diesel engines on the LNGCs are not "support facilities" and are not included within the same SIC Major Group as the FSRU. In the absence of these two conditions, the LNGCs cannot be included in the "stationary source" analysis for the Project. Broadwater Energy therefore requests EPA's concurrence that the emissions attributable to LNGCs when connected to the FSRU for the sole purpose of transferring LNG are not to be included in the PSD analysis for the Project.

C. Breakdown of LNGC Emissions/Emission Estimates

The boilers aboard a steam turbine LNGC produce steam. The combined output from the boilers is split and drives a steam turbine primarily for propulsion and a steam turbine generator to generate electricity. The electricity produced is used for ship functions such as hoteling and operation of cargo loading/unloading equipment. The electricity produced is routed to a switching board which then distributes the electricity to vessel components. Therefore, the combustion source used to produce electricity is also used to propel the vessel.

When an LNGC is docked next to the FSRU during LNG pumping, the full capacity of the boilers is not needed. An LNGC's boiler/steam turbine/electric generation capacity is sized to accommodate propulsion needs on the high seas. When pumping LNG while the vessel is docked to the FSRU, one boiler is on standby and the other boiler is operating at a reduced load while providing sufficient steam to spin the turbine generator to produce electricity for the LNG pumps and to accommodate vessel hotel needs.

LNGC emissions associated solely with offloading LNG were determined from the estimated power requirements for pumping. The current LNGC fleet is 100% steam turbine. Beginning in 2011 (the anticipated start date for operations of the Project), some slow speed diesel LNGCs may begin operating in the LNG delivery fleet such that some may be available to call on the FSRU. The LNGC fleet is discussed in more detail in Broadwater's response to EPA question #4.

The emission estimate (Table 1) shows an analysis for a 100% steam turbine vessel scenario and assumes the use of 2.7% sulfur fuel (on average). The annual emission estimate is based on 118 deliveries of LNG to the FSRU. The data used in this table is taken from Table 13 of Appendix B of Resource Report 9; the columns labeled "Annual Emissions – LNG Loading" from Resource Report 9 were refined further to break out emissions due to LNG pumping and hoteling related emissions during the LNG pumping period. See *Attachment A*. As noted in EPA's March 9 letter, the hoteling emissions are not to be included in the PSD applicability analysis.

The PTE for LNG pumping and regasification for the FSRU/vessel combination is shown in Table 2; in addition, emissions from ship hoteling and other ship functions while at berth (including the period while berthed at the FSRU but not unloading LNG) are shown. The comparisons by emission source category to the PSD 100 TPY threshold are shown in Tables 3 and 4. None of the combination of sources exceed a PSD threshold. The PTE for sulfur dioxide ("SO_2") emissions from the FSRU and the 2 boilers onboard a steam turbine LNGC is estimated at 88.1 TPY, 11.9 tons below the PSD threshold of 100 TPY for the fossil fuel boiler source category with combined heat input > 250 MMBtu/hr.

Table 1 – LNG Pumping and FSRU Regasification Emission Analysis – 250 TPY PSD Facility Threshold (all values reflect TPY)

	NOx	VOC	CO	SO_2 (assuming 2.7% S fuel)	PM_{10}	$PM_{2.5}$
LNG Carrier Offloading and FSRU Processing Emissions						
FSRU – Process Heaters (4 with 1 spare)	21	8.4	49	2.5	31	31
FSRU – Gas Turbines (2 with 1 spare)	34	9.4	30	1.6	16	16
FSRU – Other sources (emergency engines)	16	0.5	8	0.0	0.3	0.3
Current Fleet LNG Carrier while Pumping	11	0.2	0.6	84	4	4
Total Operational Process Emissions (PTE)	82	18.5	87.6	88.1	51.3	51.3
Hoteling and Other Ship Function Emissions While at Berth						
LNG Carrier Hoteling while Pumping LNG	7	0.1	0.42	56	3	3
LNG Carrier Non Loading	4	0.1	0.24	32	1.5	1.5

Period						
Total Annual Operational Non-Permit Emissions	11	0.2	0.66	88	4.5	4.5

Table 2 – LNG Pumping and FSRU Regasification Emission Analysis – 100 TPY PSD Boiler Threshold (all values reflect TPY)						
	NOx	VOC	CO	SO_2 (assuming 2.7%S fuel)	PM_{10}	$PM_{2.5}$
LNG Carrier Offloading and FSRU Processing Emissions						
FSRU – Process Heaters (4 with 1 spare)	21	8.4	49	2.5	31	31
Current Fleet LNG Carrier while Pumping	11	0.2	0.6	84	4	4
Total Boiler Related Emissions	32	8.6	49.6	86.5	35	35

Table 3 – LNG Pumping and FSRU Regasification Emission Analysis – 100 TPY PSD Steam Electric Generation Threshold (all values reflect TPY)						
	NOx	VOC	CO	SO_2 (assuming 2.7%S fuel)	PM_{10}	$PM_{2.5}$
LNG Carrier Offloading and FSRU Processing Emissions						
FSRU – Gas Turbines w/heat recovery (2 with 1 spare)	34	9.4	30	1.6	16.1	16.1
Current Fleet LNG Carrier while Pumping	na	na	na	Na	na	na
Total Emissions	34	9.4	30	1.6	16.1	16.1

ATTACHMENT A

Table 12
EMISSION FACTORS FOR LNG CARRIER

Pollutant	Sulfur Content of Fuel (wgt %)	Emission Factor (g/kW-hr) Steam Turbine Heavy Fuel Oil	Emission Factor (g/kW-hr) Slow Speed Diesel Heavy Fuel Oil	Emission Factor (lb/MMBtu) Gas Turbine LNG
NO_x	-	2.1	19.67	0.32
VOC	-	0.03	0.6	0.0021
CO	-	0.12	1.59	0.082
SO_2	1.5	9.2	6.53	0.00064
	2.67	16.3	11.63	0.00064
	4.5	27.5	na	not applicable
$PM_{2.5}$	-	0.75	1.64	0.0066
PM_{10}	-	0.75	1.64	0.0066
CO_2	-	956	682	110.0

Notes:

1. All emission factors for steam turbines, except for SO_2 with fuel sulfur content of 1.5% and 4.5% from Ref. 13, Table D.9.
2. SO_2 emission factor for 1.5% and 4.5% sulfur fuel based on fuel consumption of 305 g/kW-hr (Ref.11, Table
3. All emission factors for slow speed diesel from Ref.13. Table D.9
4. Heavy Fuel Oil is same as Residual Oil.
5. All emission factors for gas turbines from AP-42, Section 3.1 (uncontrolled emissions); assume sulfur content of natural gas of 6.8 ppm.

Table 13a

SUMMARY OF EMISSION RATES FOR LNG CARRIERS OF VARIOUS CARGO CAPACITY AND LOADING RATE WHILE AT THE FSRU

Daily Natural Gas Delivery	1	bcf/day	Estimated average daily natural gas delivery rate.
	21,095	Mg/day	Calculated from ideal gas law using standard temperature and pressure.
Annual LNG Delivery Rate by Mass	7,700,000	metric tons/yr	Maximum annual LNG delivery to FSRU
	7,700,051	Mg/yr	
LNG Density	470	kg/m^3	Design data from RR13
LNG Annual Delivery Rate by Volume	16,383,086	m^3/yr	Calculated from Annual LNG Delivery Rate by Mass and LNG Density

Pump Power requirements	2,816	ST vessel 138K m3
	3,212	SSD reliq vessel, 260K m3

Vessel	Vessel Size	LNG Loading Rate	Annual Vessel Dockings	Vessel Duration at FSRU		Power Supplied by Engines[1]		Fuel Use by Vessel at FSRU[2,3]	Maximum Hourly Emissions[4] (lb/hr)						Maximum Hourly Emissions with No Loading[5] (lb/hr)		Average Hourly Emission Over 24-Hour Period[6] (lb/hr)		Annual Emissions - LNG Loading (tpy) - Pumping and Ship Hoteling Subtotal					
				LNG Loading	No Loading	LNG Pumps	Other Equip.																	
Type	(m^3)	(m^3/hr)	(#/yr)	(hr)	(hr)	(kW)	(kW)	(tons)	NO_x	VOC	CO	CO_2	SO_2	PM_{10} ($PM_{2.5}$)	SO_2	PM_{10} ($PM_{2.5}$)	SO_2	PM_{10} ($PM_{2.5}$)	NO_x	VOC	CO	CO_2	SO_2	PM_{10} ($PM_{2.5}$)
Existing Vessel Population																								
Conventional LNGC	125,000	10,000	132	12.5	8	2,816	1,900	25	22	0.3	1.2	9,939	285	8	68	3.1	171	5	18.01	0.3	1.03	8,200	140	6
Heavy Fuel Oil (2.7%S)		13,000	132	9.6	8	3,661	1,900	23	26	0.4	1.5	11,720	337	9	68	3.1	158	5	16.34	0.2	0.93	7,438	127	6
Steam turbine propulsion		15,000	132	8.3	8	4,224	1,900	22	28	0.4	1.6	12,907	371	10	68	3.1	151	5	15.59	0.2	0.89	7,099	121	6
Conventional LNGC	140,000	10,000	118	14.0	8	2,816	1,900	27	22	0.3	1.2	9,939	285	8	68	3.1	189	6	18.03	0.3	1.03	8,210	140	6
Heavy Fuel Oil (2.7%S)		13,000	118	10.8	8	3,661	1,900	25	26	0.4	1.5	11,720	337	9	68	3.1	174	5	16.36	0.2	0.93	7,447	127	6
Steam turbine propulsion		15,000	118	9.3	8	4,224	1,900	24	28	0.4	1.6	12,907	371	10	68	3.1	167	5	15.61	0.2	0.89	7,107	121	6
Conventional LNGC	160,000	10,000	103	16.0	8	2,816	1,900	30	22	0.3	1.2	9,939	285	8	68	3.1	213	6	17.99	0.3	1.03	8,190	140	6
Heavy Fuel Oil (2.7%S)		13,000	103	12.3	8	3,661	1,900	28	26	0.4	1.5	11,720	337	9	68	3.1	195	6	16.32	0.2	0.93	7,429	127	6
Steam turbine propulsion		15,000	103	10.7	8	4,224	1,900	27	28	0.4	1.6	12,907	371	10	68	3.1	187	6	15.57	0.2	0.89	7,090	121	6
Vessel Design On-Order (Expected in-service 2008)																								
New Design LNGC	160,000	10,000	1	16.0	8	2,816	2,700	24	239	7.3	19.3	8,293	79	20	69	9.8	76	17	2	0.1	0.2	66	1	0
Heavy Fuel Oil (1.5%S)		13,000	1	12.3	8	3,661	2,700	21	276	8.4	22.3	9,564	92	23	69	9.8	70	15	2	0.1	0.1	59	1	0
Slow Speed Diesel		15,000	1	10.7	8	4,224	2,700	21	300	9.2	24.3	10,410	100	25	69	9.8	67	14	2	0.0	0.1	56	1	0
New Large LNGC	215,000	10,000	1	21.5	8	2,816	3,000	32	252	7.7	20.4	8,745	84	21	77	10.8	83	20	3	0.1	0.2	94	2	0
Heavy Fuel Oil (1.5%S)		13,000	1	16.5	8	3,661	3,000	29	289	8.8	23.3	10,015	96	24	77	10.8	90	20	2	0.1	0.2	83	1	0
Slow Speed Diesel		15,000	1	14.3	8	4,224	3,000	27	313	9.6	25.3	10,861	104	26	77	10.8	88	19	2	0.1	0.2	78	1	0
Concept Vessels In Serivce (beyond 2010)																								
New Very Large LNGC	250,000	10,000	1	25.0	8	3,212	3,200	40	278	8.5	22.5	9,641	92	23	82	11.6	92	23	3	0.1	0.3	121	2	0
Heavy Fuel Oil (1.5%S)		13,000	1	19.2	8	4,176	3,200	36	320	9.8	25.9	11,089	106	27	82	11.6	101	24	3	0.1	0.2	107	2	0
Slow Speed Diesel[(7)]		15,000	1	16.7	8	4,818	3,200	34	348	10.6	28.1	12,055	115	29	82	11.6	105	24	3	0.1	0.2	100	2	0
New Very Large LNGC	250,000	10,000	1	25.0	8	3,212	2,300	n/a	16	0.10	4.1	5,457	0.03	0.33	0.01	0.14	0.03	0.33	0	0.00	0	68	0.00	0.00
LNG fuel only		13,000	1	19.2	8	4,176	2,300	n/a	19	0.12	4.8	6,411	0.04	0.38	0.01	0.14	0.03	0.34	0	0.00	0	62	0.00	0.00
Gas Turbine Propulsion[8,9]		15,000	1	16.7	8	4,818	2,300	n/a	20	0.13	5.3	7,047	0.04	0.42	0.01	0.14	0.03	0.34	0	0.00	0	59	0.00	0.00

Notes:

1. Based on data supplied in Ref 4. LNG Pumps operate only during "LNG Loading". Other Equip. operates during "LNG Loading" and "No Loading"
2. Steam Turbine fuel use based on engine flow rate of 305 g/kW-hr (Ref. 11, Table 2.8). Steady operation while unloading is consistent with "at sea" operations.
3. Slow speed diesel fuel use based on fuel flow rate of 195 g/kW-hr (Ref. 11, Table 2.8). Steady operation while unloading is consistent with "at sea" operations.
4. Maximum hourly emission rate based on operation of vessel auxiliary engines needed to power LNG Pumps and Other Equipment.
5. Maximum hourly emission rate based on operation of vessel auxiliary engines needed to power only Other Equipment.
6. Weighted values based on emissions during Loading and No Loading periods.
7. New Very Large LNGC vessel assumed to use slow speed diesel on HFO only. Vessel will have a LNG reliquefaction plant on-board, no boil off gas available for propulsion.
8. New Very Large LNGC vessel assumed to use gas turbine capable of 22MW generation. No vessels of this type under design yet; specifications speculative only. No reliquefaction plant used.
9. Fuel rate of gas turbines estimated at 9,000 Btu/kW-hr.

Annual Emissions (tpy) - No Loading period - Ship Hoteling 8 hours						Annual Emissions - Total (tpy)						Annual Emissions - LNG Pumping Only (tpy)						Annual Emissions - Hoteling During LNG Pumping (tpy)					
NO_x	VOC	CO	CO_2	SO_2	PM_{10} ($PM_{2.5}$)	NO_x	VOC	CO	CO_2	SO_2	PM_{10} ($PM_{2.5}$)	NO_x	VOC	CO	CO_2	SO_2	PM_{10} ($PM_{2.5}$)	NO_x	VOC	CO	CO_2	SO_2	PM_{10} ($PM_{2.5}$)
5	0.1	0.27	2,114	36	1.7	23	0.3	1.3	10,314	176	8	10.76	0.2	0.615	4,896	83	4	7.26	0.1	0.415	3,304	56	3
5	0.1	0.27	2,114	36	1.7	21	0.3	1.2	9,552	163	7	10.76	0.2	0.615	4,896	83	4	5.58	0.1	0.319	2,541	43	2
5	0.1	0.27	2,114	36	1.7	20	0.3	1.2	9,213	157	7	10.76	0.2	0.615	4,896	83	4	4.84	0.1	0.276	2,202	38	2
4	0.1	0.24	1,890	32	1.5	22	0.3	1.3	10,100	172	8	10.77	0.2	0.615	4,902	84	4	7.27	0.1	0.415	3,308	56	3
4	0.1	0.24	1,890	32	1.5	21	0.3	1.2	9,337	159	7	10.77	0.2	0.615	4,902	84	4	5.59	0.1	0.319	2,544	43	2
4	0.1	0.24	1,890	32	1.5	20	0.3	1.1	8,997	153	7	10.77	0.2	0.615	4,902	84	4	4.84	0.1	0.277	2,205	38	2
4	0.1	0.21	1,650	28	1.3	22	0.3	1.2	9,840	168	8	10.74	0.2	0.614	4,890	83	4	7.25	0.1	0.414	3,300	56	3
4	0.1	0.21	1,650	28	1.3	20	0.3	1.1	9,078	155	7	10.74	0.2	0.614	4,890	83	4	5.58	0.1	0.319	2,538	43	2
4	0.1	0.21	1,650	28	1.3	19	0.3	1.1	8,740	149	7	10.74	0.2	0.614	4,890	83	4	4.83	0.1	0.276	2,200	37	2
0	0.0	0.0	16	0	0.0	2	0.1	0.2	83	1	0	0.98	0.0	0.1	34	0.32	0.08	1	0.0	0.1	32	0	0
0	0.0	0.0	16	0	0.0	2	0.1	0.2	75	1	0	0.98	0.0	0.1	34	0.32	0.08	1	0.0	0.1	25	0	0
0	0.0	0.0	16	0	0.0	2	0.1	0.2	72	1	0	0.98	0.0	0.1	34	0.32	0.08	1	0.0	0.1	22	0	0
1	0.0	0.0	18	0	0.0	3	0.1	0.3	112	2	0	1.31	0.0	0.1	46	0.44	0.11	1	0.0	0.1	48	0	0
1	0.0	0.0	18	0	0.0	3	0.1	0.2	101	2	0	1.31	0.0	0.1	46	0.44	0.11	1	0.0	0.1	37	0	0
1	0.0	0.0	18	0	0.0	3	0.1	0.2	96	2	0	1.31	0.0	0.1	46	0.44	0.11	1	0.0	0.1	32	0	0
1	0.0	0.0	19	0	0.0	4	0.1	0.3	140	2	0	2	0.1	0.1	60	1	0	2	0.1	0.1	60	1	0
1	0.0	0.0	19	0	0.0	4	0.1	0.3	126	2	0	2	0.1	0.1	60	1	0	1	0.0	0.1	46	0	0
1	0.0	0.0	19	0	0.0	3	0.1	0.3	120	2	0	2	0.1	0.1	60	1	0	1	0.0	0.1	40	0	0
0.0	0.00	0.0	9	0.000	0.001	0	0.00	0.1	77	0.00	0.00	2	0.1	0.1	60	1	0	1	0.0	0.1	43	0	0
0.0	0.00	0.0	9	0.000	0.001	0	0.00	0.1	71	0.00	0.00	2	0.1	0.1	60	1	0	1	0.0	0.1	33	0	0
0.0	0.00	0.0	9	0.000	0.001	0	0.00	0.1	68	0.00	0.00	2	0.1	0.1	60	1	0	1	0.0	0.1	29	0	0

3. There is a discussion in Page 9-14 of the October 2005 Report (or Page 9-13) of the January 2006 Report) regarding the applicability *[sic]* of PSD applicability thresholds for this proposed facility. The Report states that this proposed facility has two PSD source categories within the FSRU: 1) fossil fuel-fired steam electric plans of more than 250 MMBTU/hr heat input and 2) fossil fuel boilers (or combinations thereof) totally more than 250 MMBTU/hour heat input. Broadwater states that individual and combined emissions from these two category sources would not exceed the PSD threshold of 100 tons/year. Furthermore, Broadwater states that the primary purpose of the FSRU is the storage and regasification of natural gas and since it does not fall within the 28 recognized source categories, the 250 tons/year PSD applicability threshold applies to the FSRU process.

This approach seems to be consistent with the July 6, 1992 letter from Edwin Erickson, Regional Administrator, EPA Region 3, to Mr. George Freeman, Counsel for Reserve Coal Properties Company. This EPA letter states in Page 4 that "EPA's policy is to use the primary activity test to determine which SIC code governs and thus, which activities may be grouped into a single 'source.' However, once the source is identified, EPA will determine the proper applicability thresholds on the basis of the categories set out in Section 169(l). If a source includes an industrial operation listed under Section 169(l), the 100-ton threshold will apply to the listed operation no matter what the primary activity of the entire source." However, because EPA Region 2 has not yet received any final Report/application containing the SIC codes and the proper reapportioning of the emission estimates from the FSRU and vessels (see Comments Nos. 1 and 2 above), a final PSD applicability determination cannot be made at this time.

RESPONSE

Broadwater Energy believes that the information provided in the Resource Reports and this response will enable EPA to make a final determination that PSD does not apply to the Project.

4. Will all the vessels carrying the LNG to the FSRU have a boiler on board (or a combination of boilers) totaling more than 250 MMBtu/hour heat input? If not all vessels will have such boiler(s), give an estimate of the percent of vessels that will be at berth at the FSRU that will have boiler(s) totaling more than 250 MMBtu/hour heat input. Please specify how many boilers are on each ship and how many MMBtu/hour heat input each boiler is.

RESPONSE

As noted, the LNGCs that would deliver LNG to the Project will not dedicated to the Project and Broadwater Energy, the owner and operator of the FSRU, will have *no* ownership interest in, or control over, the LNGCs. The vessel fleet delivering LNG to the FSRU beginning in the first year of FSRU operation (2011) and beyond will likely be a mix of vessel types (steam and diesel) and may slowly change with each year beyond the first year of operation. Thus, it is likely that at the beginning of FSRU operation and as the fleet composition changes (as discussed below), some vessels carrying LNG to the FSRU will not have boilers on board totaling more than 250 MMBtu/hour, while some will. Vessels that will have boilers will be steam turbine powered vessels; each steam turbine powered vessel has two boilers aboard, each with an approximate heat input rating of 170 MMBtu/hour. However, as noted above in Broadwater Energy's response to EPA Question #2, only a partial load on one of the boilers will be needed to offload LNG cargo to the FSRU.

The current LNGC fleet (as of February 2006) consists of 196 vessels of which 194 are steam propulsion. Currently, 133 vessels are on-order (i.e., vessels to be built for which firm orders have been placed). Of these on-order vessels, 86 are steam propulsion and 47 are diesel propulsion. As these on-order vessels enter service, the composition of the worldwide LNGC fleet will change from the current 99% steam propulsion to approximately 85% steam and 15% diesel vessels based on the best estimate within the LNG shipping industry. The diesel vessels will not have boilers for propulsion/electric generation; the diesel engines will provide the mechanical drive to the electric generators. Thus, for each year from the first full year of FSRU operation (2011), an increasing percentage of vessels delivering LNG to the FSRU will likely be slow speed diesels. It is not possible with any certainty in 2006 to predict what the mix of vessel types docking to the FSRU in 2011 will be (e.g., steam or diesel propulsion), since this is entirely dependent on which LNG shippers acquire new vessels and whether those shippers are contracted to deliver LNG to the Broadwater FSRU.

BROADWATER

5. The Report must also include a discussion as to the feasibility of the gas turbines at the FSRU providing electricity to the vessels at berth so that the vessels can run the LNG pumps. This approach can potentially reduce SO_2 emissions from the vessels while at berth because the vessels will use higher sulfur fuel than the FSRU. If this is technically infeasible, detailed reasons should be provided.

RESPONSE

While the concept of cold ironing, that is, the provision of shore-based power to small craft while at berth, is not new, it is not considered to be a normal practice for commercial shipping except in dry dock where hotel services may be maintained with shore-based power. Use of shore-based power for commercial vessels during cargo operations is a recent innovation which may be feasible for certain types of vessels but is technically challenging for tankers or LNGCs during discharging operations where power requirements can be significant (as compared to existing shore-based power options). While the majority of vessels are capable of connecting to a shore-based power supply, there are technical limitations as to what services this supply could support. Broadwater Energy is not aware of any offshore LNG terminal (in service or proposed) that would provide power to vessels to facilitate the offloading of LNG cargo. Additionally, power transfer between two independently moving vessels, such as between Broadwater's FSRU and an LNGC, would necessarily be more complex than a traditional ship to shore power interface.

There are a number of safety, design, operational and commercial risk factors to be considered. A description of these factors is provided here to demonstrate the complexity of the issue.

LNGCs (such as those that may call at the Project) range in size from 125,000 m^3 to about 250,000m^3 and are powered as follows:

- Steam turbine propulsion with dual fuel (natural gas and residual oil) boilers. Cargo pumping electric power provided by steam turbine generators;
- Dual fuel (natural gas and diesel oil) diesel electric propulsion. Cargo pumping power provided by diesel generators; and
- Single fuel diesel propulsion with on-board BOG reliquefaction. Cargo pumping by diesel generators arranged for operating on residual or diesel fuel.

LNGCs have two critical ship/shore interfaces: cargo transfer and emergency shutdown (ESD) systems. These systems are virtually standardized across the industry. Electrical systems on board LNGCs vary according to the size and type of vessel, owner's preference and the shipyard where the vessel is constructed. Cold ironing of LNGCs would require significant redesign and retrofitting of the existing LNG fleet to standardize electrical interfaces.

The cargo pumping (LNG off-loading) power required for these carriers at Broadwater would range from 2.5 to 3.5 MW. Compared to propulsion needs, this power demand places a modest load on the LNGC generation system. However, it is a significant amount of electricity when considering the utility systems needed to transfer electricity from the FSRU to the LNGC. It would require large power transfer cables and cable management systems that can accommodate tide changes and independent vessel movement by the carrier and the FSRU. This is unlike shore-to-ship power transfer systems used or being considered for use in other shore-based port locations for other industries like container ships or passenger cruise ships. Those systems are designed for the transfer of power for hoteling requirements from a static location (shore) to a berthed ship. In addition, the amount of electricity transferred on a per ship basis for hoteling is significantly less than the amount needed to offload LNG cargo.

Cable management for a large electrical load, especially between two floating bodies, warrants serious consideration from a risk perspective. A critical component of all LNG transfer operations is the linked Emergency Shutdown System, which stops the cargo flow whenever an abnormal situation is experienced on the LNGC or FSRU. In the event of an abnormal situation, the loading arms can be automatically disconnected, allowing the LNGC to depart in a controlled manner. The inability to disconnect the electric cabling and revert back to normal onboard power generation on the LNGC would interfere with the ability of an LNGC to depart from an emergency situation in an expeditious manner.

In addition, each vessel type has variable power distribution arrangements and differing cargo pumping power requirements. A feature of all tanker operations is the avoidance of all ignition sources in areas where a flammable vapor could be present. Cable management from the FSRU to the LNGC would require the physical movement of large cables through potentially hazardous areas of the FSRU or carrier, rendering the activity unsafe. The FSRU would also likely require multiple cable management systems to accommodate various LNGCs which have varied voltages and power distribution arrangements.

To mitigate risk associated with safety issues like the ESD issue, additional tug boats could be required to stay on station during the cargo transfer operations to manage the carrier in the event of a loss of power either during an ESD or for other reasons while at the FSRU. This would increase overall emissions from the Project.

From an operational perspective, to minimize risk, the offloading carrier should be alongside the FSRU for the shortest time consistent with safe operations. Connection and disconnection times associated with provision of FSRU power to the carrier will increase this time.

From a design perspective, neither the FSRU nor the current and under construction LNG carriers have been designed to accommodate a power transfer load required for cold ironing. The FSRU would need to undergo an engineering analysis and redesign as well as an operational reassessment in order to accommodate power transfer. Commercially, LNGC owners may refuse to deliver LNG to the Project given the power transfer requirements and the attendant risk. As noted, Broadwater Energy will not have an ownership interest in nor control over the LNGCs which will deliver LNG the Project.

To determine if cold ironing of LNG vessels is feasible in the future, the LNG industry, in concert with port operators and various other groups such as the United States Coast Guard must conduct a thorough evaluation of all associated risk factors and, if deemed feasible, adopt industry standard practices for vessels and ports associated with LNG transport. Should the LNG industry and maritime organizations choose to evaluate the concept of cold ironing of active duty vessels, Broadwater will actively participate in these discussions.

6. The Report must include a discussion on the feasibility of the FSRU providing fuel oil containing 1% Sulfur content or less to the vessels carrying the LNG while at berth for the purposes of off-loading and on-board processing of the LNG. Also, it should address the feasibility of the ships burning lower sulfur fuel on their own while at berth.

RESPONSE

Marine bunker fuel specifications are defined in the International Organization for Standardization (ISO) 8217 2005. This standard specifies the requirements for petroleum fuels for use in marine diesel engines and boilers. It specifies ten categories of residual fuel and four categories of distillate fuel, one of which is 1% sulfur diesel for emergency use in diesel engines.

In addition the "International Maritime Organization's (IMO's), Safety of Life at Sea (SOLAS) Convention, Chapter II-2 Construction Regulation 15 Arrangements for Oil Fuel, Lubricating Oil and Other Flammable Oils" defines the prescriptive limitations that apply to the use of oil as a fuel source, onboard a ship.

As defined in ISO 8217, bunker grade DMX has a maximum 1% sulfur content and has a minimum flashpoint of 43 degrees Celsius (109 °F). A general rule, the SOLAS Convention recommends that no oil fuel with a flashpoint of less than 60°C (140°F) shall be used as a primary fuel source. SOLAS further describes that the temperature of the space in which the oil fuel is stored or used shall not be allowed to rise within 10°C below the flashpoint of the fuel. SOLAS permits general use of oil fuel having a flashpoint of less than 60°C (140°F) but not less than 43°C (109 °F). For ships on worldwide trade routes, achieving the required separation of temperature between the storage space and 1% sulfur fuel oil would be a difficult criterion to meet.

In principle, DMX grade fuel oil may only be used for emergency equipment. As a result, fuel oil of this specification generally is available in drums and not in bulk and, therefore, could not be used by LNGCs as fuel for propulsion or cargo unloading.

Low sulfur diesel fuel will be stored on the FSRU for the operation of its diesel generators and start-up operations for gas turbine power generators and process heaters. The FSRU has not, however, been designed for bunkering fuel oil for transfer to LNGCs and hence there is no storage capacity for heavy fuel oil on the FSRU. The normal ship to shore or ship to ship fuel oil interface is arranged for "bunker in" or "bunker out" transfer of fuel oil. In general, these systems do not directly connect to the fuel burning systems and its equipment.

Fuel transferred to the LNGC would be segregated from the LNGC's own fuel. This may not be possible based on the standard arrangements for the LNGCs' fuel tanks. The provision of 1% sulfur fuel oil from the FSRU may also not be acceptable for some LNGCs because of their specific boiler arrangement, as this fuel can only be supplied to a limited number of fuel oil burners during the establishment and re-establishment of main power.

The transfer of fuel from the FSRU to the offloading LNGC creates an additional ESD interface. From a risk management perspective, this is unacceptable in terms of emergency disconnect time and the increased risk of oil spills during fuel transfer. The overall length of time for the offloading LNG carrier at the FSRU would also be increased as fuel transfer operations would need to be completed as a separate operation before the unloading of LNG could commence, potentially offsetting any emissions reduction that might be realized from using low sulfur fuel during offloading.

Finally, bunkering significant quantities of fuel oil on the FSRU would create the need for frequent trips by a refueling vessel to replenish supply. This would create the potential for fuel oil spills during transit, transfer to the FSRU, and transfer from the FSRU to the LNGCs.

Request:

Regarding potential alternative offshore interconnection points with the Iroquois Gas Transmission System (IGTS), describe any changes to the natural gas throughput capabilities to the New York City and Long Island markets that would result from moving the interconnection point further upstream (north) on the IGTS pipeline.

Response:

Changing the interconnect point to one further upstream (north) on the IGTS pipeline would have an adverse effect on the ability of the Project to maximize deliveries of gas to the Long Island and New York City regions. As the interconnect point moves further northward, the level of hydraulic impairment increases.

This issue is discussed, in part, in Resource Report 10 (Alternatives), Section 10.7.3.5 (Route 5), which contains an assessment of an alternative pipeline route which contemplates an offshore interconnect with IGTS at MP 7.1, as measured from the Connecticut shore. While this alternative provides for a shorter connecting pipeline length (12.4 miles) than the preferred alternative (21.7 miles), it is also 11.2 miles further north along the IGTS pipeline. The route alternative is depicted in Figure 1.

Table 1 (which is presented at Table 10-14 on page 10-75 of Resource Report 10) summarizes the relative lengths from the FSRU location to the IGTS Hunts Point meter station (in New York City) and to the South Commack meter station on Long Island. From the table, it can be seen that while the total distances traversed are similar, gas flows must pass through a higher proportion of 24-inch pipeline for the Route 5 alternative. For the path to the Hunts Point meter station, gas flows must pass through an additional 11.2 miles of 24-inch pipeline. The same is true for the South Commack meter station.

EIR2-10

Table 1 Pipeline Route Length Comparison

Segment		Preferred Route 2 (NY)		Alternative Route 5 (CT)	
	Pipeline Diameter	Pipeline Length (miles)	% of Route Length	Pipeline Length (miles)	% of Route Length
FSRU to IGTS Hunts Point M/S (New York)	30"	21.7	33%	12.4	18%
	24"	45.0	67%	56.2	82%
	Total	66.7	100%	68.6	100%
FSRU to IGTS South Commack M/S (Long Island)	30"	21.7	56%	12.4	31%
	24"	17.1	44%	28.2	69%
	Total	38.8	100%	40.6	100%

As a result of the gas having to be transported a greater distance in a smaller diameter pipeline, there is a greater pressure drop for the Connecticut alternative compared to the preferred alternative. This is due to the smaller cross-sectional area available for a given amount of flow, resulting in greater friction along the pipe wall. The cross-sectional area of a 30-inch pipeline is approximately 56% greater than that for a 24-inch pipeline.

Broadwater has modeled the maximum hydraulic delivery capability for both of these potential routes. For each route, two cases have been considered. Case 1 assumes maximum deliveries at the Hunts Point meter station (i.e. New York City), while making allowance for existing contractual delivery requirements for South Commack. Case 2 assumes deliveries are maximized at the South Commack meter station (i.e. Long Island), while, making allowance for existing contractual delivery requirements at Hunts Point. The cases are summarized in Table 2.

In Cases 1 and 2, the gas would have to travel an additional 11.2 miles through the smaller 24-inch Iroquois pipeline for the Connecticut alternative. As a result of the greater pressure drop for the this alternative, the ability to deliver gas volumes to either the Hunts Point or South Commack meter stations is significantly reduced.

EIR 2-10

Table 2 Maximum Hydraulic Delivery Capability for IGTS

	Delivery Capability (mmcf/d) Preferred Route 2 (NY)	Delivery Capability (mmcf/d) Alternative Route 5 (CT)	Reduction (mmcf/d)
Case 1 – Maximum Deliveries to NYC			
Gas Supply			
FSRU Sendout to IGTS Interconnect Point	1,000	1,000	
Physical Flow on IGTS toward CT from Interconnect Point	-71	-187	
Total Flow toward L.I. and NYC	929	813	
Gas Deliveries			
To Hunts Point	642	526	116 (18.1%)
To South Commack	287	287	
Total Deliveries to L.I. and NYC	929	813	
Case 2 – Maximum Deliveries to South Commack (LI)			
Gas Supply			
FSRU Sendout to IGTS Interconnect Point	1,000	1,000	
Physical Flow on IGTS from CT toward Interconnect Point	290	5	
Total Flow toward L.I. and NYC	1,290	1,005	
Gas Deliveries			
To Hunts Point	321	321	
To South Commack	969	684	285 (29.4%)
Total Deliveries to L.I. and NYC	1,290	1,005	

From the table, it can be seen that for Case 1, a 116 mmcf/d (18.1%) reduction in delivery capability at Hunts Point is associated with the Connecticut alternative. In Case 2, a 285 mmcf/d (29.4%) reduction at South Commack results.

These results are based upon the physical delivery capability provided from the FSRU, without any added facilities on the Iroquois system, while accommodating both forecast IGTS transportation contracts and incremental flow from the Project. Broadwater's hydraulic analysis of the Iroquois system suggests that for the Connecticut alternative to match the physical delivery capability of the preferred alternative, additional facilities would be needed including approximately 20 miles of 24-inch subsea pipeline looping (located in a new right-of-way parallel to, but separated for construction purposes from, the existing IGTS pipeline crossing of Long Island Sound) coming onshore at Northport

EIR 2-10

where approximately 11,500 horsepower of compression would need to be constructed. These additional facilities would result in a substantial additional environmental impact that can be avoided by selecting the preferred alternative.

EIR 2-10

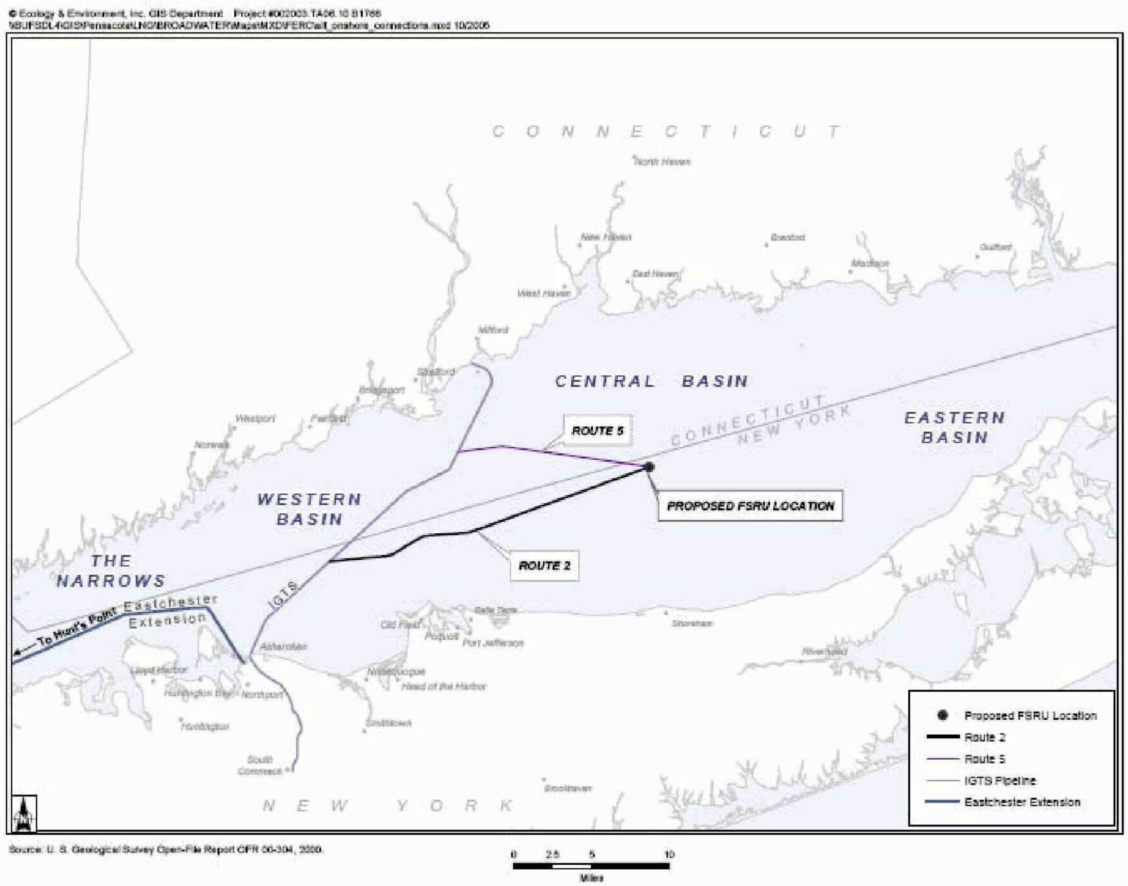

Figure 1 – Alternative Offshore Connections

EIR2-11

Request:

Provide a comparative analysis, including tabular summaries, of the potential offshore and onshore impacts associated with the proposed Project and an offshore storage and regasification alternative located on the south side of Long Island, and a new pipeline between the offshore terminal and an interconnect with the existing IGTS pipeline.

Response:

Potential system alternative(s) located off the south shore of Long Island, with LNG storage and regasification occurring in the Atlantic Ocean rather than in Long Island Sound, are the focus of this response. In Resource Report 10, Broadwater identified a similar offshore terminal location as "CLNG A", but discounted its viability from an environmental, economic and engineering standpoint. A major consideration was the significant weather-related impacts upon cargo transfer in the open ocean environment. The offshore Atlantic alternative, including associated pipelines, was further discussed and rejected in Broadwater's recently-filed Coastal Zone Consistency Determination (NYDOS-April 2006) which has been included in the FERC docket and made a part of the FERC record.

Two potential alternative routes to interconnect an offshore Atlantic Ocean terminal with the existing Iroquois system are presented in this EIR response. One alternative traverses Long Island to tie in to the existing IGTS South Commack meter station. The second alternative stays offshore through the New York/New Jersey Harbor and traverses up the East River before making landfall at Hunt's Point with a tie in to the existing IGTS Hunts Point meter station.

Potential onshore and offshore pipeline routes were evaluated using publicly available information. Routes considered in this comparison are described below and shown on Figure 1. Broadwater's preferred route is also presented.

- **Preferred Route (as presented in Broadwater's application) -**This route is 21.7 miles in length, is centrally located within Long Island Sound, and maximizes the distance from either the Long Island or Connecticut shorelines. This route is located completely offshore and does not impact any sensitive shoreline or onshore areas.

- **Alternative 11-1** – This route is 40.5 miles in length and includes an offshore terminal on the southern shore of Long Island due south of the Jones Beach area. This routing maintains a straight-line approach to Jones Beach State Park, going through Hempstead Bay before making landfall at Wantagh. The onshore route then generally follows existing roadway corridors toward the north before connecting at the South Commack meter station. Alternative 11-1 is not preferred due to the significant coastal habitat and submerged aquatic vegetation encountered in Hempstead Bay, coupled with the significant urban congestion along the onshore corridor.

- **Alternative 11-2** – This route is 50.2 miles in length and includes an offshore terminal on the southern shore of Long Island due south of the Jones Beach area. The route then follows a westerly direction through the Rockaway Inlet and the New York Bight via the East River with a connection at Hunt's Point. Alternative 11-2 encounters the greatest amount of potential sediment contamination along the route in the East River and the New York Bight. These areas are contaminated with several heavy metals and PCBs as a result of sediment deposition and dredge disposal from upper watershed areas including the Hudson River and other industry along the New York Bight with outfalls directly into the East River. Sewer overflows with increased inputs from the heavily populated New York City area also impact this area. This route would more than double the amount of in-water construction impact, and require construction in heavily used and restricted waterways as compared to Broadwater's preferred alternative.

The analysis and supporting tables present a comparison of some of the key environmental and engineering considerations and conditions along the proposed marine and onshore pipeline routing alternatives that led to the selection of the preferred alternative. Alternatives 11-1 and 11-2 start at an offshore location but end at different locations onshore, namely the South Commack meter station and Hunt's Point, respectively. Alternative 11-1 includes an onshore component. Broadwater's preferred route is entirely offshore.

The comparative data analysis presented in Table 1 was gathered as part of a desktop study effort and presents the impacts associated with in-water and onshore features associated with each potential alternative. A summary of environmental and engineering constraints is presented in Table 2.

EIR2-11

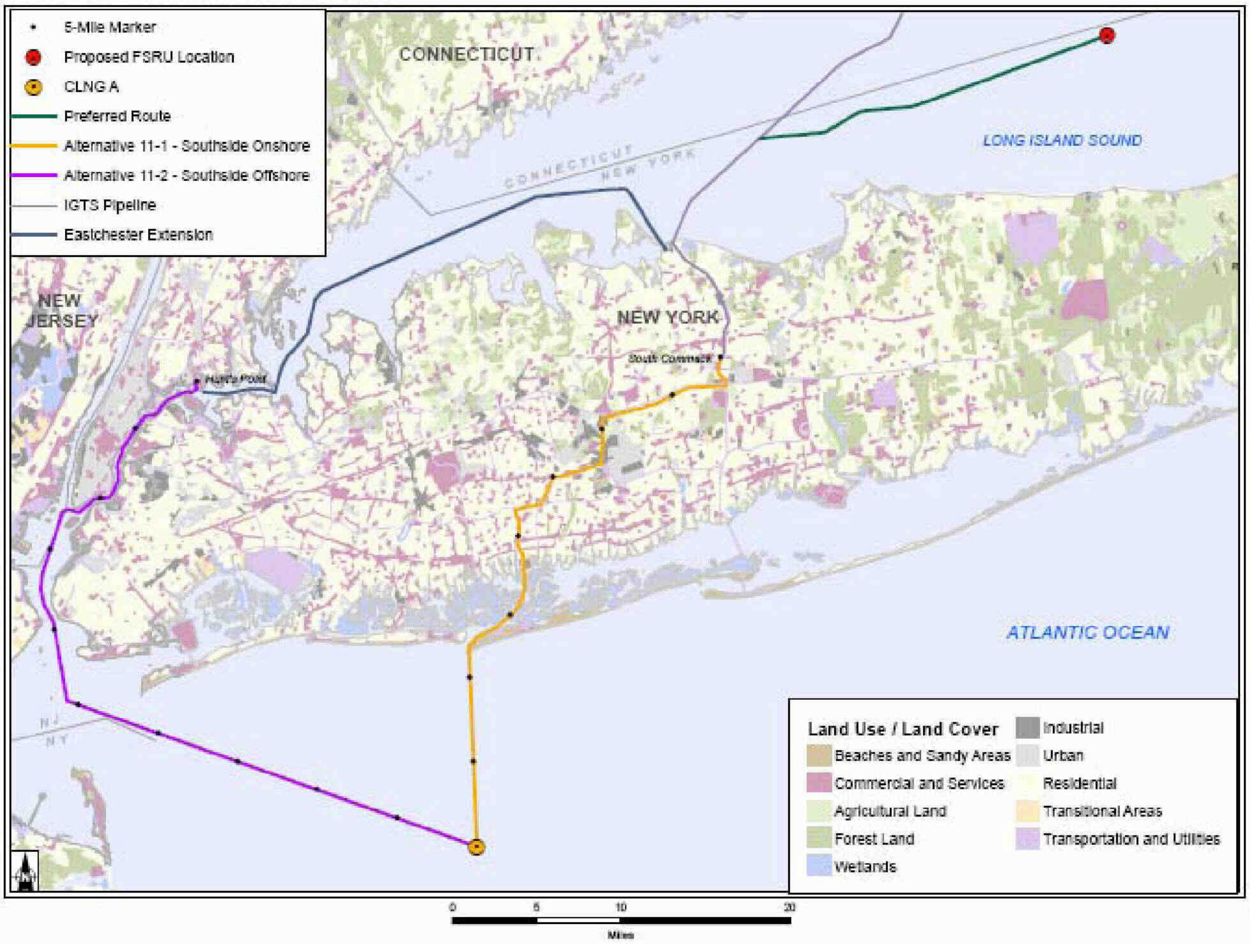

Figure 1 Alternative Pipeline Routes 11-1 and 11-2 from CLNG A

Alternative 11-1 Southside Onshore

Alternative 11-1 is 40.5 miles in total length, which is approximately twice the length of the Preferred Route alternative (21.7 miles). Alternative 11-1 traverses approximately 17.6 miles of offshore open water on the south side of Long Island in the Atlantic Ocean and makes landfall through Jones Inlet in the vicinity of Jones Beach State Park. Less than a mile of the Jones Beach State Park would be traversed (0.3 miles) by the route. Additional land uses that this route crosses include, among others, residential (7.5 miles) and a small amount of forested land. This route was chosen to avoid the need for a landfall along the southern Long Island shoreline. Rather, the pipeline was routed to make landfall in an interior bay near an existing roadway with a crossing of Hempstead Bay.

While avoiding an Atlantic shore crossing, this alternative would result in significant impact to Hempstead Bay, which is recognized as a Significant Coastal Fish and Wildlife Habitat Area due to extensive marsh development. Construction would result in significant impact to this resource.

The watershed of the Hempstead Bay area where Alternative 11-1 makes landfall exhibits the highest proportion of watershed rendered impervious by roads, parking lots and roofs. Residential development along canals, tributaries and the shoreline is increasing the pressure on the natural bay areas causing increased runoff and contaminant loading as indicated by the presence of contaminated soils or sediments (*see* Table 1). Stormwater runoff from this developed landscape is the most significant source of pollution reaching the tributaries and bays. Elevated levels of coliform bacteria are responsible for the closure of several acres of shellfish beds and local beaches. Nutrients from these point and non-point sources promote the area's extensive seaweed and algal growth that have contributed to the loss of valuable submerged aquatic vegetation, while nutrients and sediments in stormwater runoff are responsible for impacting essential fish habitat. Petroleum hydrocarbons are also noted as sediment and water quality pollutants. Thus water quality in this area is affected by both non-point and point sources of pollution. The delicate biological condition of the landfall area and existing condition of the nearshore environment, which includes essential fish habitat and the highest area of submerged aquatic vegetation (4.5 miles), when compared to other proposed alternatives leads to the conclusion that this is not a preferred pipeline route.

Once onshore, this alternative traverses some very densely developed communities of southern Nassau and Suffolk Counties, Long Island (i.e. Massapequa [est. population 22,000], Bethpage [est. population 16,000], and Deer Park [est. pop 28,000]). To the extent possible, the pipeline would be co-located with existing roadway infrastructure on Long Island. Because of congestion, construction would likely require closing a portion of roadways, and would require specialized construction techniques to accommodate the lack of space, resulting in substantially greater construction time. The communities traversed by this alternative are characterized as relatively affluent communities with a substantial amount of high-end residential and commercial development. Alternative 11-1 would also be required to cross a total of 10 existing utilities. The Preferred Route traverses no residential areas and two offshore utility crossings but no onshore utilities. Other characteristics of the route are identified in Table 1.

Based on the considerable potential impacts resulting from construction of this alternative, Broadwater does not consider this to be a viable option.

Alternative 11-2 Southside Offshore

Alternative 11-2 is 50.2 miles in total length, which is approximately 30 miles longer than the Preferred Route alternative (21.7 miles). The route is located primarily in water

(49.6 miles), traversing the Atlantic Ocean and the East River, crossing through Queens and Bronx Counties with a connection at Hunts Point. Of particular note, this route would cross an estimated 13 roadways, bridges, and/or tunnels. This route would also cross 14 utilities comprised of seven cables and seven pipelines, along the marine portion of this route. The Preferred Route traverses two offshore utilities. Other characteristics of the route are identified in Table 1.

Alternative 11-2, at 50.2 miles long, represents the proposed route with the greatest potential to impact benthic communities and disturb contaminated sediments. This route traverses the New York Bight and East River, which contain potentially highly contaminated sediments that would become suspended in the water column during pipeline construction and may cause depositional issues in adjacent areas. This can further impact the essential fish habitat that is present along the proposed route and other organisms that exist throughout the water column.

Another characteristic of this alternative is that pipeline construction would occur in nearly 24 miles of a designated navigable waterway with limited work space (e.g. the East River and New York Bight) and excessive vessel traffic issues that increase the risk of collision and spills that would impact water quality, the biological community and local commerce. Pipeline construction in the East River would not likely be by conventional laybarge and towed plow method; it would likely involve pre-dredging of the pipeline trench followed by pipeline installation by a submerged tow method where pipe sections are made up onshore then launched, towed and welded into place. This type of construction would take several months to complete compared to conventional laybarge construction, and would be hampered by interference with normal vessel traffic in the East River.

Table 1 Comparison of Preferred Route and Alternatives

Parameter	Preferred Route	Alternative 11-1 – Southside Onshore	Alternative 11-2 – Southside Offshore
Length (miles)	21.7	40.5	50.2
Utility crossings	2	10	14
Compressor Stations	0	1 minimum (on a platform located offshore)	1 minimum (located onshore)
Construction corridor/ROW (miles)	(21.7 offshore)	22.9 (17.6 offshore)	0.6 (49.6 offshore)
Estimated number of on shore non-typical work areas [1] (does not include road crossings)	0	12	1
Estimated acreage of permanent and construction ROW (does not include cable sweep on Preferred route)	16/199	29/285	35/530
Land Use			
Forested land (No. miles traversed)	0	0.3	0
Residential land (No. miles traversed)	0	7.5	0
Estimated number of residences within 50 feet of edge of construction ROW	0	457	0
Federal Parks (conservations areas) (No. miles traversed)	0	0	0
State Parks (conservation areas) (No. miles traversed)	0	0.3	0
Scenic River Corridors (No. miles traversed)	0	0	0
Roadways/Bridges/Tunnels (Number encountered)	0	0	13
Onshore Biological Components			
Freshwater wetlands (No. miles traversed)	0	12	3.2

Table 1 Comparison of Preferred Route and Alternatives

Parameter	Preferred Route	Alternative 11-1 – Southside Onshore	Alternative 11-2 – Southside Offshore
Tidal wetlands (No. miles traversed)	0	2.6	1.6
Significant coastal habitat (No. miles traversed)	0	5.5	0
Count of stream and creek crossings	0	11	0
Refuge Areas		0	0
Onshore soils types			
Onshore soils susceptible to erosion (No. miles traversed)	0	23.6	0
Sole-source aquifers encountered/shallow groundwater (No. miles traversed)	0	Along 22 miles of onshore route	0
Offshore Biological Components			
Fisheries use areas (No. miles traversed)	0	0.06	32
Submerged Aquatic Vegetation(No. miles traversed)	0	4.5	0
Offshore Marine Use Components			
Nearest Distance to Shore from Terminal (miles)	9.7	11.4	11.4
Within 1 mile of Dumping Areas (Active/Inactive)	1	0	0
Bathymetry Depth (meters)	-18 to -39	0 to -25	0 to -30
Submarine Cable Crossing	2	0	7
Within 1 mile of Lightering Area	1	0	0
Wrecks within 1 mile	9	12	1
Ferry Route Crossing	1	0	0

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Table 1 Comparison of Preferred Route and Alternatives

Parameter	Preferred Route	Alternative 11-1 – Southside Onshore	Alternative 11-2 – Southside Offshore
Potentially Contaminated Soils or Sediments (Present: Yes/No)			
PCBs	No	UNK	Yes
Dioxin	No	UNK	Yes
Metals	No	Yes	Yes
Pesticides	No	UNK	Yes
PAHs	No	UNK	Yes
Petroleum hydrocarbons	No	Yes	Yes
Sediment Types (miles traversed)			
Gravelly Sand	0.4	UNK	NA
Sand	1.8	UNK	NA
Sandy Silt, Clayey Silt, or Silt	8.7	UNK	NA
Sand- Silt-Clay	4.9	UNK	NA
Silt-Clay/Sand	6.0	UNK	NA
Deposition	11.3	UNK	NA
Erosion	1.7	UNK	NA
Sorting	8.7	UNK	NA

UNK = Information was not available at the time this analysis was performed.
1 Size of on-shore non-typical work areas cannot be estimated unless a detailed route reconnaissance and site specific pre-engineering study is conducted

Route Alternative	New-Build Pipeline Length	Environmental Constraints	Engineering Constraints
Alternative 11-1 FSRU on south side of Long Island and onshore at Jones Beach with Connection at South Commack	40.5 Miles <u>22.9 Miles Onshore</u> <u>17.6 Miles Offshore</u>	•• Route involves greatest disturbance to submerged aquatic vegetation (4.5 miles) in shoreline areas •• Disturbance of contaminated sediments in shoreline areas during construction •• Disturbance to tidal and inter-tidal wetland communities containing sensitive habitats •• Disruption to traffic patterns and highway use for extended periods during pipeline construction due to restrictive rights-of-way •• Unstable soils for land-based components due to high water table •• Specialized dewatering techniques required to account for high water table and discharge of the water during construction •• Potential impacts to the Nassau – Suffolk sole source aquifer	•• Landfall in sensitive near shore and beach environments •• Co-location along busy and congested urban roadways •• Construction and operation of a pipeline in a residential area •• Intermediate compression required, necessitating the construction of at least one compressor station

Route Alternative	New-Build Pipeline Length	Environmental Constraints	Engineering Constraints
Alternative 11-2 FSRU on south side of Long Island with connection offshore to pipeline at Hunt's Point (through East River)	50.2 Miles <u>0.6 miles onshore</u> <u>49.6 miles offshore</u>	•• Disturbance and increased sediment load on the water column of potentially highly contaminated sediments in the New York Bight and East River with need for removal and dredge disposal during and after pipeline construction •• Increased sedimentation due to excessive pipeline length •• Increased risk for collisions in high traffic areas of the New York Bight and East River with risks for spills •• Potential to encounter more cultural resources such as shipwrecks with longer offshore pipeline length •• Increased disturbance to benthic habitats due to increase pipeline length	•• Disruption of navigation channel use during pipeline installation •• Construction under Verrazano Bridge •• High traffic through the New York Bight and East River during construction will limit workspace area •• Intermediate compression required, necessitating the construction of at least one compressor station, likely offshore

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Recommended Route

Based on the desktop evaluation of these additional alternatives and comparison of the critical factors affecting pipeline routing, the preferred alternative identified in Broadwater's application continues to be placement of the FSRU approximately 9 miles offshore of Long Island in its current proposed location with an offshore pipeline connection to the Iroquois Gas Transmission System via a 21.7 miles east-west pipeline. The data presented in this alternatives assessment further supports Broadwater's original alternatives analysis resulting in the selection of the proposed Project, the terminal site and the Preferred Route.

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Request:

Provide an environmental, engineering, and economic analysis of an alternative pipeline route that would proceed due south from the proposed FRSU location, make landfall near Scott's Beach on Long Island, and extend onshore south and westward to an interconnect with the existing IGTS pipeline near Smithtown, NY. The analysis should include the following information so that a quantitative comparison can be made with Broadwater's proposed route in this area:

a. The length of pipeline (miles)
b. The acreage of both the permanent and construction rights-of-way
c. The estimated size and location of any non-typical work areas required
d. The estimated number of residences within 50 feet of the edge of the construction right-of-way
e. The number of waterbodies and wetlands crossed
f. The acres of agricultural land affected
g. The acres of forest cleared
h. The miles of right-of-way that would be parallel or adjacent to existing rights-of-way.

Response:

Two potential alternative alignments originating from the proposed FSRU site in Long Island Sound were evaluated. One alternative has a landfall at Scott's Beach while the second alternative comes ashore near Shoreham. The Shoreham landfall route mirrors the routing proposed by Islander East. Each of the alternatives is compared to Broadwater's proposed route to assess potential environmental and engineering constraints. Based on this analysis, Broadwater remains confident that its proposed route would result in the least environmental impacts, and maximizes public safety.

Potential onshore and offshore pipeline routes were evaluated using publicly available information. Routes considered in this comparison are described below and shown on Figure 1.

- **Alternative 12-1** – This route is 41.9 miles in length originating from the proposed FSRU location in Long Island Sound. The route follows a southerly direction from the FSRU making landfall at Shoreham, then traveling south along existing roadways until it reaches Yaphank along the proposed Islander East alternative route. The route then travels due west along the same route as the proposed IGTS Brookhaven lateral with a connection at the existing IGTS South Commack meter station. Compression is required, with an approximate

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- 7,000 horsepower compressor station located near Farmingville Long Island. Alternative 12-1 is the longest onshore route and traverses through the most sensitive onshore terrestrial habitats including the Central Pine Barrens. While the portion of Pine Barrens traversed is considered a controlled growth area, the Pine Barrens also function as a major groundwater recharge area for the Nassau-Suffolk sole source aquifer.

- **Alternative 12-2** - This route is 34.0 miles in length, originating from the proposed FSRU location in Long Island Sound. The route follows a straight line with onshore landfall at Scott's Beach. The route then generally follows existing roadways in a southerly direction before connecting at the existing IGTS South Commack meter station. Compression is required, with an approximate 2000 horsepower compressor station located near the junction of Nesconset Road and Nicolls Road. Alternative 12-2 impacts the most residential area, with 10.6 miles of pipeline route through residential areas.

The analysis and supporting tables below present a comparison of some of the key environmental and engineering considerations and conditions along the proposed marine and onshore pipeline routing alternatives. Alternatives 12-1 and 12-2 start at Broadwater's proposed FSRU site in Long Island Sound, come onshore and end at the same location at the existing IGTS South Commack meter station. Broadwater's preferred route is entirely offshore, thereby avoiding shore crossings and additional compression facilities.

In addition to the comparison of impacts based on offshore and onshore features presented in Table 1, there are additional requirements for longer pipeline routes that must be considered, including construction of compressor station facilities. Environmental and engineering constraints are presented in Table 2.

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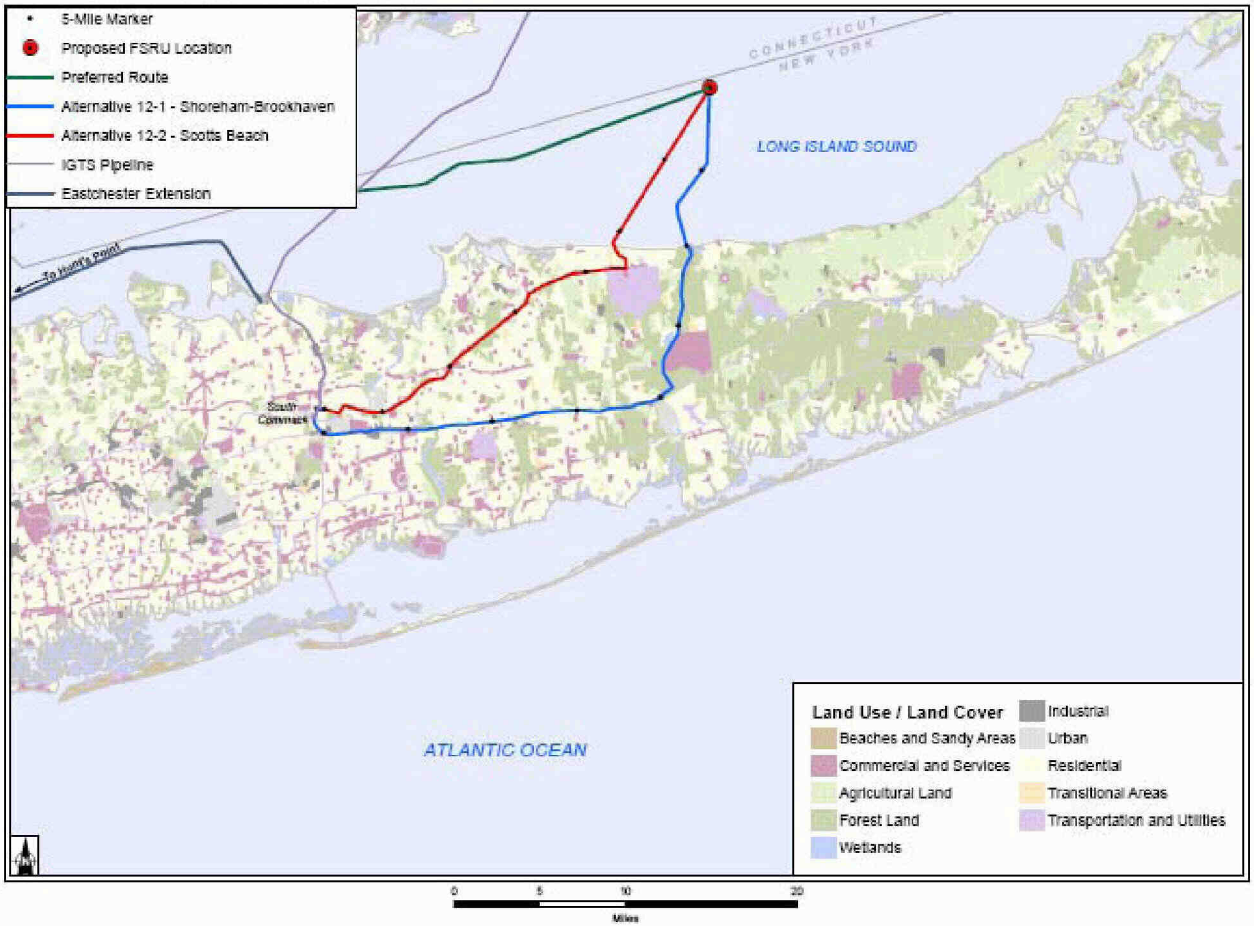

Figure 1 Alternative Pipeline Routes 12-1 and 12-2 from FSRU

Alternative 12-1 Northside-Brookhaven

Alternative 12-1 is 41.9 miles in total length, which is approximately twice the length of the Preferred Route alternative (21.7 miles). Alternative 12-1 traverses open water (9.9 miles), residential areas (6.0 miles) and forested land (8.4 miles). The Preferred Route is comprised entirely of open water, without onshore land use impacts. Alternative 12-1 includes a pipeline shore crossing in a location previously approved by FERC as part of the Islander East Pipeline project, while the Preferred Route requires no shore crossing. Alternative 12-1 also crosses 9 utilities and will require construction of a compressor station near Farmingville, Long Island. Other characteristics of the route are identified in Table 1.

The most notable issue associated with this route alternative from an environmental and engineering standpoint is potential impact to the Central Pine Barrens, located in Brookhaven, NY. Alternative 12-1 traverses approximately 8 miles of the southern portion of the Central Pine Barrens along the I-495 corridor in Brookhaven, NY. This region is protected under the Long Island Pine Barrens Protection Act of 1993 and is overseen by the Central Pine Barrens Joint Planning and Policy Commission. The Central Pine Barrens is ecologically important because of its regionally rare and unique wetland and upland communities and its function as a primary groundwater recharge area for the Nassau-Suffolk sole source aquifer system.

In addition to the Central Pine Barrens, other potential impacts include the presence of soils which are susceptible to erosion due to the high water table along nearly 33 miles of the onshore route. There also are areas of known soil contamination onshore that were confirmed near a gasoline facility near Motor Parkway that would need to be excavated and properly disposed of during pipeline installation. Offshore sediment contamination also will be a concern during pipeline installation since this is an area known to contain elevated levels of PCBs, dioxin and metals, which have led to many fish consumption advisories for the north shoreline of Long Island.

Construction in the shoreline area will result in increased suspension of potentially contaminated sediments in the water column which can impair water quality and increase deposition, which is a major concern for this significant coastal habitat that contains sensitive shellfish beds, an essential fish habitat and delicate tidal wetland communities.

Alternative 12-2 Northside-Scott's Beach

Alternative 12-2 is 34.0 miles in total length and is approximately 12 miles longer than the Preferred Route (21.7 miles). Alternative 12-2 traverses open water (10.7 miles), residential areas (10.55 miles) and forested land (2.9 miles). The Preferred Route is comprised of 100% open water, impacting no onshore area. Alternative 12-2 also includes a pipeline shore crossing at Scott's Beach – a beach location in Suffolk County that is surrounded by residential development. Alternative 12-2 also would cross two utilities and require a compressor station near the junction of Nesconsett Road and Nicolls Road. Broadwater's Preferred Route traverses two offshore submarine utilities but no onshore utilities.

Construction in the shoreline area will result in increased suspension of potentially contaminated sediments in the water column that can decrease water quality and increase deposition, which is a major concern for the delicate tidal communities, including an essential fish habitat. Another feature of this route is construction along 23-miles of shallow groundwater areas which are part of the Nassau-Suffolk sole source aquifer system that supplies drinking water for many of the residential areas along the proposed route. This is a very sensitive system and would require specific sedimentation controls, trench dewatering, and hydrostatic test water fill and discharge techniques during construction to avoid potential impacts. Other characteristics of the route are identified in Table 1.

Table 1 Comparison of Preferred Route and Alternative

Parameter	Preferred Route	Alternative 12-1 Northside Shoreham-Brookhaven	Alternative 12-2 Northside Scott's Beach
Length (miles)	21.7	41.9	34.0
Utility crossings	2	9	2
Compressor Stations	0	1	1
Construction corridor/ROW (miles)	(21.7 offshore)	32 (9.9 offshore)	23.3 (10.7 offshore)
Estimated acreage of permanent and construction ROW (does not include cable sweep on Preferred route)	16/199	99/306	40/225
Estimated number of on shore non-typical work areas [1] (does not include road crossings)	0	10	3
Miles of new ROW parallel or adjacent to existing ROW (estimated)	0	> 90%	>90%
Estimated relative CAPEX factor	100%	190%	160%
Land Use			
Forested land (No. miles traversed)	0	8.4	2.9
Residential land (No. miles traversed)	0	6.0	10.6
Estimated number of residences within 50 feet of edge of construction ROW	0	280	262
Federal Parks (conservations areas) (No. miles traversed)	0	0	0
State Parks (conservation areas) (No. miles traversed)	0	7.9 - Central Pine Barrens	0.1

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Table 1 Comparison of Preferred Route and Alternative

Parameter	Preferred Route	Alternative 12-1 Northside Shoreham-Brookhaven	Alternative 12-2 Northside Scott's Beach
Scenic River Corridors (No. miles traversed)	0	0	0
Roadways/Bridges/Tunnels (No. encountered	0	0	0
Onshore Biological Components			
Freshwater wetlands (No. miles traversed)	0	3.2	3.0
Tidal wetlands(No. miles traversed)	0	0.8	0.8
Significant coastal habitat (No. miles traversed)	0	0.01	0.3
Count of stream and creek crossings	0	3	3
Refuge Areas	0	0	0
Onshore soils types			
Onshore soils susceptible to erosion (No. miles traversed)	0	32.2	23.3
Sole source aquifers encountered / shallow groundwater (No. miles traversed)	0	0 / 32	0 / 23
Offshore Biological Components			
Fisheries use areas (No. miles traversed)	0	0	0
Submerged Aquatic Vegetation(No. miles traversed)	0	0	0
Offshore Marine Use Components			
Nearest Distance to Shore from Terminal (miles)	9.7	9.7	9.7
Within 1 mile of Dumping Areas (Active/Inactive)	1	0	0
Bathymetry Depth (meters)	-18 to -39	0 to -40	0 to -40

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Table 1 Comparison of Preferred Route and Alternative

Parameter	Preferred Route	Alternative 12-1 Northside Shoreham-Brookhaven	Alternative 12-2 Northside Scott's Beach
Submarine Cable Crossing	2	0	0
Within 1 mile of Lightering Area	1	0	0
Wrecks within 1 mile	9	9	19
Ferry Route Crossing	1	0	0
Potentially Contaminated Soils or Sediments (Present: Yes/No)			
PCBs	No	Yes	Yes
Dioxin	No	Yes	Yes
Metals	No	Yes	Yes
Pesticides	No	UNK	UNK
PAHs	No	Yes	UNK
Petroleum hydrocarbons	No	UNK	UNK
Sediment Types (miles traversed)			
Gravelly Sand	0.4	0	0
Sand	1.8	1.2	1.8
Sandy Silt, Clayey Silt, or Silt	8.7	7.7	8.5
Sand- Silt-Clay	4.9	0.95	0.47
Silt-Clay/Sand	6.0	0.2	0.22

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Deposition	11.3	7.7	8.7
Erosion	1.7	0.9	1.4
Sorting	8.7	1.4	0.85

UNK = Information was not available at the time this analysis was performed

1 Size of non-typical work areas cannot be estimated unless a detailed route reconnaissance and site specific pre-engineering study is conducted

Route Alternative	New-Build Pipeline Length	Environmental Constraints	Engineering Constraints
Alternative 12-1 FSRU with connection at Shoreham and Brookhaven Lateral	41.9 Miles 32 miles onshore 9.9 miles offshore	•• Unstable soils for land-based components due to high water table •• Specialized dewatering techniques to account for high water table and discharge of the water during construction •• Potential impacts to the Nassau – Suffolk sole source aquifer •• Communities of special concern impacted by construction include the Central Pine Barrens which is identified as a Critical Environmental Area and red maple hardwood swamp •• Encounter potentially contaminated soils onshore •• Increased sedimentation in sensitive coastal areas due to pipeline construction •• Noise and visual impacts in surrounding areas during pipeline construction and operation from onshore compressor station •• Disturbance of contaminated sediments in shoreline areas	•• Disruption and obtaining permission from affected landowners •• Construction and operation of a pipeline in a residential area •• Landfall in sensitive nearshore and beach environments •• Co-location along busy and congested urban roadways •• Siting of a new-build onshore compressor station

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Route Alternative	New-Build Pipeline Length	Environmental Constraints	Engineering Constraints
		during construction •• Disturbance to tidal and inter-tidal wetland communities containing sensitive habitats •• Disruption to traffic patterns and highway use for extended periods during pipeline construction due to restrictive rights-of-way	

Route Alternative	New-Build Pipeline Length	Environmental Constraints	Engineering Constraints
Alternative 12-2 FSRU with connection at Scott's Beach southerly to South Commack metering station	34.0 Miles <u>23.3 miles onshore</u> <u>10.7 miles offshore</u>	•• Increased sedimentation in sensitive coastal areas due to pipeline construction •• Noise and visual impacts in surrounding areas during pipeline construction and operation from onshore compressor station •• Disturbance of contaminated sediments in shoreline areas during construction •• Disturbance to tidal and inter-tidal wetland communities containing sensitive habitats •• Disruption to traffic patterns and highway use for extended periods during pipeline construction due to restrictive rights-of-way •• Unstable soils for land-based components due to high water table •• Specialized dewatering techniques to account for high water table and discharge of the water during construction •• Potential impacts to the Nassau – Suffolk sole source aquifer	•• Landfall in sensitive nearshore and beach environments •• Co-location along busy and congested urban roadways •• Siting of a new-build onshore compressor station •• Disruption and obtaining permission from affected landowners •• Construction and operation of a pipeline in a residential area

Recommended Route

Based on the desktop evaluation of these additional alternatives and the comparison of the critical factors affecting pipeline routing, the preferred alternative identified in Broadwater's application continues to be placement of the FSRU approximately nine miles offshore of Long Island in its current location with an offshore pipeline connection to the IGTS via the 21.7 miles east-west pipeline. The data presented in this alternatives assessment further supports Broadwater's original alternatives analysis resulting in the selection of the proposed Project, the terminal Site, and the Preferred Route.

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document upon each person designated on the service list compiled by the Secretary in this proceeding in accordance with the requirements of Rule 2010 of the Commission's Rules of Practice and Procedure.

Dated at Washington, D.C. this 19th day of May, 2006.

/s/ Brett A. Snyder
Brett A. Snyder